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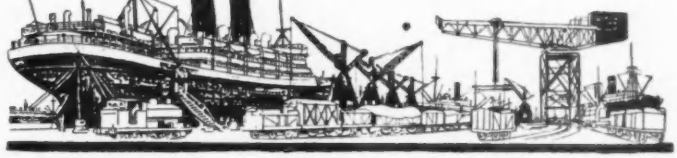
CONTRIBUTIONS:

All Letters and Contributions intended for Publication should be addressed to:—
K. R. DOGGETT, Editor,
"The Dock and Harbour Authority,"
19, Harcourt Street, London, W.1.
Telephone: PADdington 0077/8.

The Dock & Harbour Authority



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Editorial Comments

The Port of Durban, South Africa.

The Port of Durban, commercial gateway of the province of Natal, is situated on the south-east coat of Africa, and is one of the principal ports of call for vessels sailing on the Cape route to the East, and a coaling depot of the first importance.

Of recent years, there has been a steady improvement in harbour facilities and a notable increase in the volume of shipping visiting the port. This expansion of trade, may, to a great extent, be attributed to the exigencies of the recent war, but following the conclusion of hostiilities, instead of the expected return to normal conditions, it has been found that the activity of the port has been maintained. According to a report in the " Bulletin " issued by South African Railways and Harbours, to whom we also are indebted for the article on Durban to be found elsewhere in this issue, more ships have been arriving at the port in recent months than ever before, excepting the abnormal war-time convoys, and the demand for berths has sometimes taxed all the harbours resources.

This favourable position has largely been brought about by a progressive scheme of port development which was commenced in 1936 and was carried on at an increased tempo immediately following the declaration of war. Notable among the improvements was the new " T " Jetty, the construction of which, in effect, doubled the quay space in the Point area, and greatly facilitated the quicker turn-round of shipping, so enabling new records to be established in the handling of incoming ships and their cargoes.

To build the " T " Jetty, 124 concrete caissons, each 60-ft. long, 52-ft. high and 26-ft. wide and weighing 1,800 tons, were sunk end to end in a straight line to form the quay wall, and the rearward site was then filled with 3,500,000 cubic yds. of sand and spoil, pumped in by dredgers or dumped by trucks. Dredging was an important part of the work, and 7,250,000 cubic yds. of spoil were removed from the bay to provide a minimum depth of 40-ft. at low tide.

Notwithstanding the improvements which have already been carried out, there is still room for further development, and it is therefore of interest to note that, in April, 1946, the South African Government appointed a Durban Bayhead Development Committee with the following terms of reference. " To examine and report upon the future of the Durban bayhead area, as well as that portion of Salisbury Island not occupied by the Admiralty, and produce a plan showing future wharves and other reservations which should now be decided upon as long-term proposals, particularly those requiring waterfront facilities."

The Committee is now actively engaged in prosecuting its enquiries and formulating a programme.

Radar and Navigation in Harbour Waters.

In May of last year, the British Government held, in London, an International Meeting on Radio Aids to Marine Navigation, the proceedings of which were briefly referred to in an Editorial Comment in our issue of June, 1946. The findings and reports of the discussions of the delegates from the twenty or more countries attending that conference created world-wide interest, and in order to further the work started so auspiciously, the United States Government has organised a second meeting on similar lines, which is being attended by delegates from sixty nations. The convention was opened in New York on the 28th April last, and will terminate, on the 9th instant, at New London, Connecticut. The delegates are being informed of the latest policy and progress in the development of marine radio aids, and the programme, consisting mainly of lectures and technical discussions, also includes a series of demonstrations of marine radio and radar equipments at sea and on shore.

An announcement by the Ministry of Transport recently issued to the press, says that the British Government is giving the fullest co-operation towards ensuring the success of the present meeting, and welcomes the continued international exchange of scientific knowledge and opinion on this subject, and will strongly support any measures for the development and improvement of devices and systems which will reduce navigational risks.

To this end, a United Kingdom delegation composed of representatives of various Government Departments, the Lighthouse Authorities and the Shipping and Radio industries, after holding a series of preliminary meetings and compiling a complete statement of this country's policy and aims in marine radio navigation aids, arranged to present a number of papers to the American convention, outlining the progress made in the United Kingdom since the London meeting of last year.

So much publicity has been given to this subject in the popular press that, among laymen, there is a tendency to assume that Radar has overcome all the navigator's difficulties and anxieties, from position-finding to safe navigation even in the thickest fog, but such is by no means the case, and encouraging as is the progress that has been made to date, there are still many problems to be solved, particularly where the complications inherent in international transactions and agreements are concerned. The deliberations of the present conference will therefore be watched with interest, and the delegates from the many different countries will have the good wishes of all who are concerned in any way with the development of scientific aids to increase the safety of life at sea.

As stated in our previous comment, the new navigational aids, though chiefly applicable to shipping, are receiving increased con-

Editorial Comments—continued

sideration from port officials who are necessarily associated with navigational movements in confined waters and are accordingly taking note of the latest developments in radar appliances. An outstanding example of this practical interest is the installation at the Port of Liverpool of an apparatus of the latest type, and our readers will derive much useful information from the article, to be found elsewhere in this issue, which has been courteously supplied by Capt. H. V. Hart, the Marine Surveyor of the Mersey Docks and Harbour Board.

Liverpool is one of the first ports in the world to utilise Radar on a full-scale basis, and at a recent meeting of the Mersey Docks and Harbour Board it was announced that the different specifications submitted during the past few months have been critically examined by the Board and their technical advisers, and that the task of constructing the Liverpool installation had been entrusted to the Sperry Gyroscope Co., Ltd., of Brentford, Middlesex. The equipment, which will include an aerial scanner weighing 2 tons, rotating on the top of an 80-ft. steel tower erected at the seaward end of the North Docks System will be the first of its kind in the world. In the control room a number of different displays will show large scale pictures of the approach channels. These pictures will show accurately the positions of all the buoys in Liverpool Bay and enable, for the information of the Port Authority, the position of all ships to be plotted from moment to moment within a distance of 20 miles. Since radar rays penetrate both dark and fog, the installation will be unaffected by conditions of visibility and its completion should greatly assist the smooth running of the Port and enable it to remain open under conditions that, to-day, would seriously impede the movement of shipping.

The detailed design and construction of the installation is now in hand, and it is hoped the work will be completed within the next twelve months.

The Grounding of the "Queen Elizabeth."

The unfortunate grounding for 26 hours on the 14th-15th April of the Cunard-White Star liner *Queen Elizabeth* in Southampton Water approaches when within a few miles of her berth at Southampton is a grave reminder of the navigational risks involved in harbour pilotage in entrance channels and emphasises the responsibilities of Harbour Authorities for the maintenance of adequate depths and buoyage in their approaches. The delay in scheduled time, with the cost of towage and other expenditure by the Shipping Company concerned, must involve a loss of several thousand pounds. Happily the vessel, after a most creditable operation for lightening the ship, and altering trim, was after some abortive attempts, ultimately refloated with no further damage than a superficial scraping of the hull. The consequences of such a grounding had it been on a rocky bottom instead of the sand and stiff clay encountered in this case, could, of course, be very serious, especially at Spring tides, as is instanced by recent cases of groundings on the Goodwin Sands where vessels have broken their backs and become total losses.

The stranding of the *Queen Elizabeth* occurred just off Calshot on the port-hand bank of the Channel marked at this point by Bourne Gap buoy which is stated to have been only 200-ft. off the ship's starboard bow when grounded. The ship was therefore, apparently outside the dredged margins of the navigable channel, and her turn to starboard could hardly have been as satisfactory as was expected by those on board. This is not the first time that an important liner has gone aground at this turning point. The *Berengaria* grounded there in 1935 and the *Aquitania* at a point much nearer Calshot Spit in the same year.

It should be noted that whilst several ships have grounded in positions near Bourne Gap Buoy and this is outside the limits of the Board's jurisdiction, the Southampton Harbour Board with the Southern Railway have made considerable improvements in this approach by dredging up to 1935. This has involved the widening, deepening and straightening of this approach, which, in fact, has a least width of 1,000-ft. right up to Calshot.

As reported by Captain Ford, in command of the *Queen Elizabeth*, poor visibility had nothing to do with the grounding of his ship, although fog prevailed in adjacent areas of the Solent.

A navigational difficulty encountered by vessels when manœuvring in water of shallow draught is that they do not readily respond to movements of the helm. The neap tides prevailing at the time of the accident may have exerted an influence by materially reducing the draught which would have been available at springs.

The necessity for safe and easy access for shipping to ports is so obvious that all harbour authorities must be anxious to adopt all practicable means for giving effect within the limit of their resources to this fundamental requirement. Entrance channels to ports are in many cases far from ideal; London, Liverpool, New York and Antwerp, as well as others, with their tortuous approaches have physical difficulties of their own, which cause impediments to navigation, from which Southampton Water with its favourable natural conformation and special tidal facilities is happily exempt.

The Southampton Harbour Board is not directly affected by the *Queen Elizabeth's* grounding outside the navigable channel, but it may be assumed that as this body includes representatives of the Admiralty, Trinity House and all major shipping interests concerned, the improvement of the harbour and approaches must be under continual review.

East African Port Development.

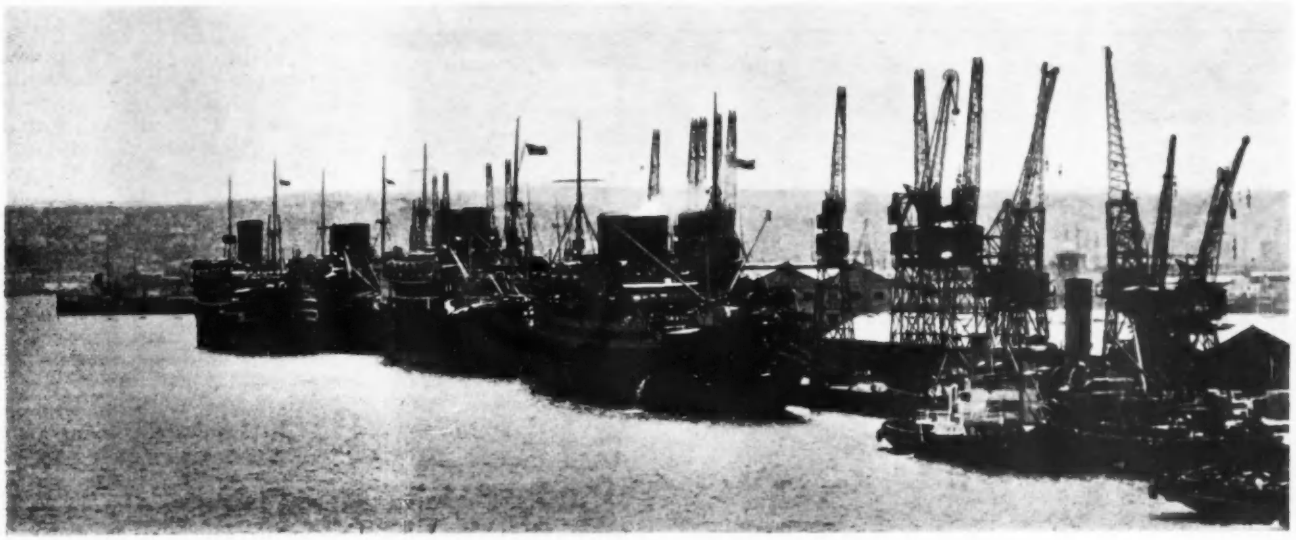
The recent announcement in the press and on the radio, that the British Government has accepted the recommendation of a technical mission that a deep-water port should be constructed at Mto Mtwara in the Southern Province of Tanganyika Territory, again draws public attention to the ambitious and far-reaching scheme for the production of Groundnuts in East and Central Africa, the plans for which have been approved by the Government and were published as a White Paper early last February.

Explaining the origin of the scheme, the White Paper recalls that, in March of last year, Mr. F. Samuel, managing director of the United Africa Company, submitted to the Secretary for the Colonies and the Minister of Food, a plan for the mechanised production of groundnuts in East Africa, and in order to investigate thoroughly the proposals put forward, the Government despatched a mission, consisting of Mr. A. J. Wakefield, formerly Director of Agriculture in Tanganyika, Mr. J. Rosa of the Colonial Office, and Mr. D. L. Martin, head of the Plantations Department of the United Africa Company.

In their report, the Wakefield mission recommended the creation of 107 units of cultivation, each of 30,000 acres—80 in Tanganyika, 17 in Northern Rhodesia and 10 in Kenya. The 80 units in Tanganyika will be located in three main areas in the territory, two of which—consisting of 450,000 acres—will be served by the existing railway which connects with the port of Dar Es Salaam. In the case of the remaining and far larger block of units situated in the Southern Province however, the mission reported that, at present, transport facilities are practically non-existent as the roads are primitive and there is no railway and no port worthy of the name.

It was therefore obvious that the provision of a new port, equipped with the necessary loading and cargo handling facilities and connected by rail with the growing areas is essential, and the Government accordingly despatched a technical mission, in the latter half of February last, to investigate the prevailing conditions and make recommendations on the suitability of certain sites for the construction of a deep-water port. The mission consisted of Mr. P. E. Millborne of the Ministry of Transport, Capt. N. Willcock, Assistant Marine Superintendent, Union Castle Line, and Mr. O. Hardie, of Messrs. Coode, Vaughan Lee, Frank & Gwyther, Consulting Engineers, and upon arrival in Africa, was augmented by the inclusion of a number of senior officials of the Tanganyika Government Railways and Port Services. The salient facts from the Report which was issued at the end of the tour will be found elsewhere in this issue, as well as the reasons for the selection of Mto Mtwara where it is planned to build a port capable of handling about 500,000 tons of groundnuts yearly, which is the estimated maximum output of the growing areas situated about 120 miles inland.

Mto Mtwara is a perfect natural harbour able to shelter an unlimited number of the largest ships. It has a minimum depth of water of 78-ft. and many other favourable features which cannot be found anywhere else on the East Coast of Africa.



A congestion of shipping at Durban Harbour.

The Port of Durban

An Account of Recent Developments

[CONTRIBUTED]

DURBAN is situated in latitude 29° 52′ 48″ South, longitude 32° 2′ 48″ East, on the south-east coast of Africa, and is 812 nautical miles from Table Bay Harbour, 6,993 miles from London via the Cape and 7,785 miles via Suez. The Port of Durban ranks with Table Bay Harbour (Capetown) as one of the two principal ports of South Africa. The ports rival each other in that, while the *value* of the trade that flows through the Cape port is the greater, and it handles far more passenger traffic, the Natal port has the advantage in *volume* by virtue of its coal trade. The histories of the two ports contrast strangely, for whereas Cape Town has a history going back 300 years and one of steady development, more or less unhindered by wars and bloodshed, that of Durban goes back little more than a century that was crammed with incidents and stories of triumphs over difficulties and dangers.

HISTORY.

Vasco da Gama was the first of the old Portuguese navigators to sight the bay that now forms one of the finest ports on the Indian Ocean, and, from the fact that this event took place on Christmas Day, 1497, arises the name "Natal." It was not, however, until 1823 that Lieutenant Farewell, in command of the brig, *Salisbury*, made acquaintance with this beautiful land-locked bay. At that time there was not more than 6 feet of water over the bar that formed a barrier to ships wishing to enter the bay.

In 1850 the first harbour engineer began to build two breakwaters, designed to force the flow of water down one channel and so to scour the sand away. This was fairly successful, as by 1854 there was a depth of 21 feet on the bar, but this was no permanent solution. In 1861 a new scheme was tried, and proved unsuccessful after £130,000 had been spent. By 1868 it was reported that there was only 10 feet of water over the bar at spring tide, and by 1882 this figure had decreased to 6 feet. In 1887, after diamonds and gold had been discovered at Kimberley and Johannesburg, the trade of the port suddenly began to grow enormously, and this again focussed attention on the necessity for improving the harbour.

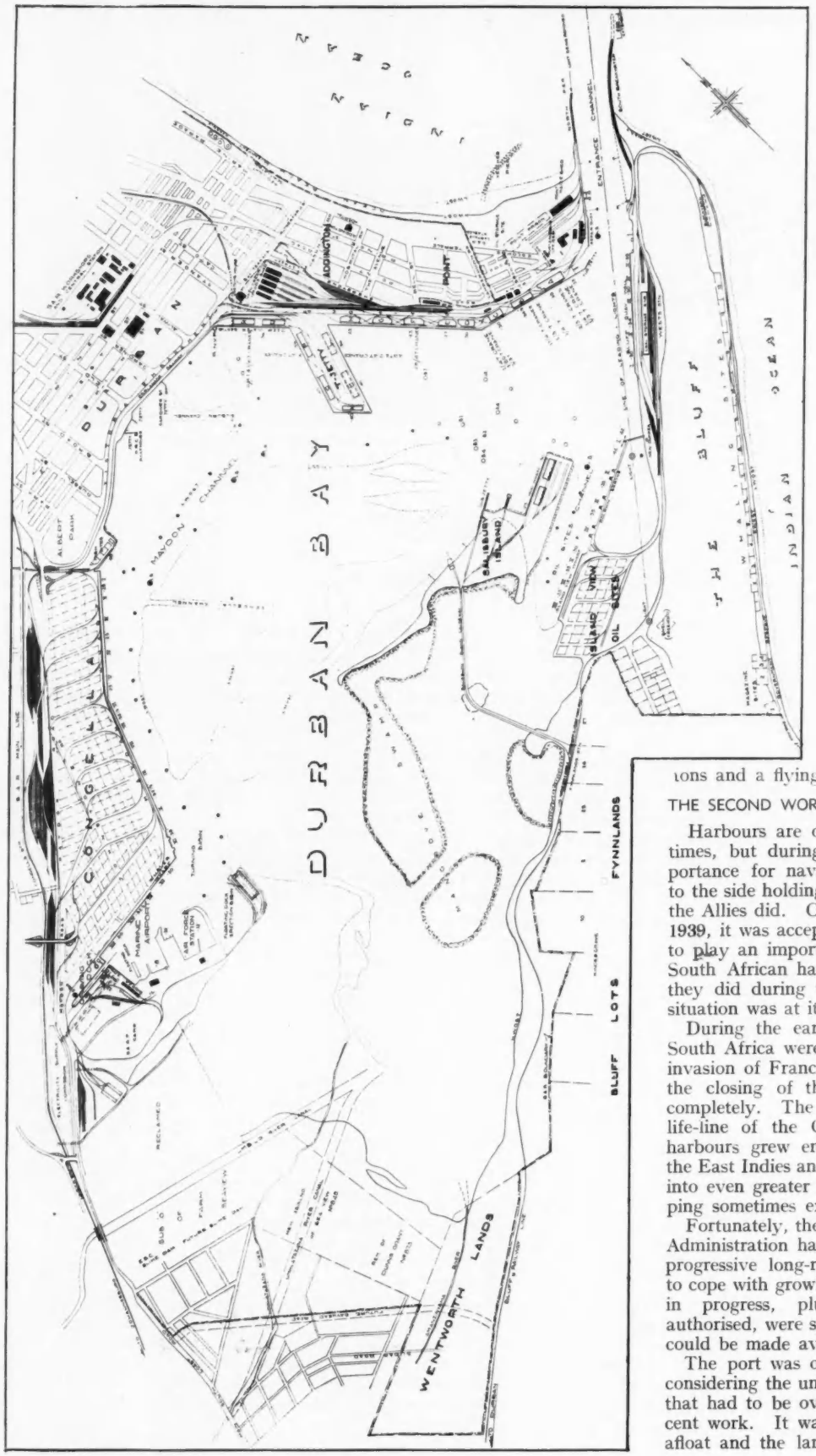
In 1882 a new attempt at construction of piers had been launched, under the Milne and Coode scheme. Dredgers were purchased in 1889, and by 1892 the sand bar was dredged to 16 feet and the south training wall extended by 1,552 feet. By 1900 the depth on the bar had been increased to 19½ feet, and the highlight of the struggle was the entry of the first mailship, the *Armadale Castle*, in June, 1904, by which time the channel was more or less 25 feet deep. So, after many years of ceaseless and untiring effort, the battle against the sand and the ocean was won, conscripting to the service of commerce and industry an extensive inland sheet of water.

Although the victory had been won, it had to be consolidated, and the increasing size of ships demanded a steady deepening of the channel. By 1907 the depth was 33½ feet at L.W.O.S.T. In 1932 the construction of the South Breakwater and North Pier was completed. The South Breakwater extends from the Bluff to a distance of over 2,300 feet into the sea, the North Pier running parallel for a distance of 1,100 feet. The width of the channel so formed is 600 feet, and this is now dredged to a depth of 42 feet at L.W.O.S.T. The phenomenal sand-drift at Durban requires the attention of seven powerful dredgers.

Prior to 1850, Durban Harbour had no sheds or stores, and cargo had to be discharged into small boats which were beached through the surf, the merchandise being then transferred to ox-wagons for distribution. Capital for large schemes of improvements was lacking, and development on shore was on a small scale until the meteoric rise of the Witwatersrand gold mining industry brought the capital. By 1892, new wharfage was constructed, two cranes and three large sheds erected. During 1901, Durban berthed 955 ships with a net register tonnage of almost two millions, and handled 1,562,000 tons inwards and 1,528,000 tons outwards. By 1907, the wharfage had been increased to 3,085 feet, and mechanical coaling appliances had been erected to serve the growing coal trade.

At the time of Union in 1910, the expenditure on Durban harbour works had reached a total of £3,941,419. The Union Government continued the progressive policy of harbour development. To meet the growing coal bunkering and export trade, the extension of the coaling appliances and sites was authorised in 1912, and by 1915 the Union Government had spent £432,810 on improving Durban harbour.

Port of Durban—continued



By 1922 the port could claim to be a major harbour. It possessed warehouse accommodation with a floor area of 557,000 square feet, seven tugs, 47 electric and hydraulic cranes, deep-water berths up to 38-ft. 6-in. at L.W.O.S.T., and a floating dock 475 feet long with a capacity of 6,500 tons. (This dock was later replaced by a smaller one).

In 1925, the Prince Edward Graving Dock was completed. Situated near the head of the bay, 4½ miles from the sea, it has a length of 1,166 feet, a breadth at entrance of 110 feet, and depth on sill of 41 feet at H.W.O.S.T. Until a year or two ago, it remained easily the largest graving dock in the southern hemisphere, and it is still the seventh largest dock in the world, and the eighteenth largest dock in the world by comparing the product of length, breadth and depth. It represented a great advance in the harbour facilities offered and could accommodate ships far larger than any trading in South African waters so that for many years the entrance channel leading to the dock was not dredged to the equivalent depth to that on the sill. The cost of the dock was approximately £2,000,000.

Other additions to the harbour before 1939 were a pre-cooling store to take 1,800 shipping tons; a floating dock 350 feet long, 88 feet wide, to lift 4,000 tons; a terminal grain elevator with a capacity of 42,000 tons and a flying-boat base.

THE SECOND WORLD WAR.

Harbours are of vital importance to a country at all times, but during a war they become of supreme importance for naval and military purposes, particularly to the side holding the outside lines of communication, as the Allies did. On the declaration of war in September, 1939, it was accepted that Durban would be called upon to play an important role, but no one thought that the South African harbours would occupy the vital position they did during the long period of the war when the situation was at its most serious.

During the early part of the war, the harbours of South Africa were not unduly strained, but the German invasion of France, the entry of Italy into the war, and the closing of the Mediterranean changed the picture completely. The South African route became the main life-line of the Commonwealth, and demands on the harbours grew enormously. The Japanese invasion of the East Indies and the loss of Singapore brought Durban into even greater prominence, and the demands of shipping sometimes exceeded the available facilities.

Fortunately, the South African Railways and Harbours Administration had, prior to the war, embarked upon a progressive long-range scheme of harbour development to cope with growing peace-time demands, and the works in progress, plus additional facilities subsequently authorised, were speeded up as fast as men and materials could be made available.

The port was operated under considerable stress and, considering the unusual war-time demands and difficulties that had to be overcome, the harbour staff did magnificent work. It was never thought that the largest liners afloat and the largest naval ships, which had not been

Port of Durban—continued

seen at Durban in times of peace, would become regular users of the port and would require to be handled at all times and in all weathers, often at night under black-out conditions.

A further factor was that for naval reasons, including a shortage of escort vessels during the most difficult period in 1941 and 1942, shipping had to be spread as little as possible, and so was concentrated in Capetown and Durban, with the result that for some time the important harbours of East London and Port Elizabeth were unable to make their full contribution.

Graving Dock, Congella, Durban.

In the early days of the war, the principal difficulty was in handling cargo, and accumulation of import cargo was serious and continuous. Airmails had been withdrawn, the surface mail service was very irregular, and neither manifests nor importers' documents were available, so that sheds overflowed with uncleared cargo. These difficulties were accentuated after the bombing of United Kingdom ports commenced, and the congestion of cargo was a serious handicap in handling the large transports, their personal equipment and stores, and many large naval escort ships which called at Durban consequent on the closing of the Mediterranean. The ordinary organisation was not designed to deal with this unprecedented situation and the South African Union Cabinet appointed a Port Director, responsible to the Minister of Railways and Harbours, to co-ordinate the efforts of the naval, military and civil authorities, and he maintained close contact with all these and with the Ministry of War Transport and later the United States War Shipping Administration representatives, with very good results.

Although Durban did not actually hear the sound of enemy guns, submarines were active in its proximity, all too often successfully, and the black-out imposed in 1942 brought its usual difficulties and interference with essential work.

Shortly after war broke out, the Marine Airport was completed. To provide facilities for a base for the Royal Navy, Salisbury Island, lying toward the southern shore of Durban Bay, was connected to the mainland by a causeway and road and rail access provided; water, light and power lines laid down and fuelling facilities provided. Jetties were constructed, dredging undertaken, and the ground raised and levelled with a view to its use by the Admiralty as a dockyard and ship-repairing base. The Admiralty turned Salisbury Island into a naval base with extensive repair facilities, which were of extreme value during the war.

For handling of general cargoes, the Point area had always been the main wharf and shed area. In 1936, construction of the "T" Jetty, which juts out at an angle from the Point wharves, was commenced, and this work was speeded up as much as possible, practically doubling the wharfage in the Point area by providing an extra 6,240 feet. The word "jetty" is somewhat of a misnomer, as it is 860 feet wide. It was constructed by floating concrete caissons into position and sinking them.

Prior to the war, ships requiring fuel oil had to be shifted to Island View, where the oil storage tanks were located and where bulk oil cargoes were discharged. To avoid this loss of time, limited oil storage was provided at the Point and all berths in that area equipped for fuel oil bunkering. At the same time, the Island View Wharf was extended by 500 feet and additional land reclaimed for oil storage tanks.

In the vicinity of the graving dock a large flying-boat base was constructed. A large basin was dredged, surrounded by spoil banks, with an entrance closed by sheet steel piles. In this basin a 17,000-ton floating dock was built and floated out after withdrawing the piles. To permit of dry-docking large capital ships and merchant ships whose normal draught had been increased by torpedo damage, the access channel to the Prince Edward Graving Dock was dredged, the Maydon channel was dredged to —40-ft. and the entrance channel was widened and deepened to —40 feet L.W.O.S.T.

To assist in ship repair work, the Administration constructed a special caisson berth with a draught of 42 feet, for capital ships requiring repairs or refitting; four concrete dolphin berths with a depth of 35 feet; and also deepened the Island View channel.

The coal bunkering and export demands grew very rapidly, and a new truck dumper and two coal transporters were erected, whilst a new gravity marshalling yard for the coal traffic was reclaimed.

In all, the war-time development of Durban Harbour equalled many years of peace-time progress, and fortunately the work was not solely of an emergency or temporary character, but fits in well with the long-range plan of future harbour development. The work was not entirely carried out in well-balanced stages as would happen in normal times, but the only important difference is that the "T" jetty was constructed in quick time, leaving the sheds and cranes to be provided later.

WAR-TIME TRAFFIC.

Shipping

From September, 1939, to August, 1945, 19,213 vessels of all descriptions entered Durban Harbour, including naval ships. In addition, there was continual shifting of ships between Point, the coaling appliances, the oil berths, Maydon Wharf and the Graving Dock. During the six years, 34,241 internal ships' movements were made by the pilots and tug crews.

The peak year was 1942, when arrivals, departures and shiftings totalled 7,844, an average of 215 per day. On the 28th May, 1942, there were 130 vessels at Durban Harbour, including 57 at the outer anchorage, outside the bar. The submarine menace frequently necessitated clearing the outer anchorage, and on three occasions ships were berthed two or three or sometimes four abreast.

Cargo

During the six years, 31,400,244 tons of cargo were landed, shipped and transhipped at Durban, an average of 5¼ million tons a year. This was achieved in spite of constant accumulation of cargo, depletion of staff, black-out conditions, and loss of cargo

Port of Durban—continued

Aerial View of Durban Harbour showing the new " T " Jetty.

working days when convoys consisting of large transports and naval escorts were in port. From May, 1940, to August, 1945, 1,373,292 tons of war supplies, equipment and material were shipped and 261,229 tons landed.

Passengers

Normal passenger traffic practically ceased, except for refugees and evacuees. With regard to movements of troops, military personnel embarked on 931 ships and disembarked from 857, while 54 calls were made by hospital ships.

Embarkations and disembarkations by United Kingdom and Imperial troops totalled just under half-a-million, and by South African troops totalled 230,000, whilst a further 280,000 United Kingdom and Imperial troops passed through Durban. Nearly 150,000 prisoners of war embarked and disembarked at Durban.

Dry Docking

The graving dock and floating dock were occupied throughout the war by a total of 1,585 vessels, of which 520 were naval vessels, including many large battleships, several badly damaged, and merchant ships seriously damaged by enemy action.

Other

Over one thousand million gallons of fresh water was supplied to ships. The figures of stores supplied are not available, but the figure of 1,297,690 dozen eggs may be of interest, and also the 674,000 gallons of beverages!

Ship Repairs

Before the war, Durban's ship-repair industry was a small one, largely concerned with annual refitting of whale catches and only occasionally handling heavy repairs. In this, more than in any other respect, the impact of the war was terrific. There were thousands to fit with defensive armament and further armament as time went on, de-gaussing gear, plastic armour, etc., naval ships to refit, engine repairs to merchant ships, severe cases of damage through collisions in convoy, and a great deal of other work. The necessity of despatching ships from British ports without waiting for normal repair work, and then the increasing number of ships damaged by enemy action, made tremendous demands on the industry, which was quite incapable of coping with the situation. A Director of Ship Repairs was appointed, a repair staff built up, the railway mechanical workshops and every available facility brought into the scheme, with results that could not have been dreamed of in normal times. During the period February, 1941, to September, 1945, 4,377 merchant vessels and 1,755 naval ships—a total of 6,132—were repaired at Durban.

DURBAN HARBOUR TO-DAY.

The entrance to the harbour is situated between, on the south, the Bluff, a conspicuous wooded promontory about 195 feet high, falling steeply down to Durban Bay, and, on the north, a low arm of land, the extremity of which is known as the Point, so that the Bay is almost completely enclosed. On the inner face

Port of Durban—continued

of this arm, to the right on entering, are the principal quays, wharves and warehouses.

The entrance is 600 feet wide, between the South Breakwater and North Pier, the navigable width of the harbour entrance being 450 feet, widening to 600 feet in the entrance channel, the working depth at the harbour entrance (outer channel) is 42 feet L.W.O.S.T., and in the inner channel 39 feet. The depth on the bar and in the bay is maintained by seven powerful dredgers.

Unloading Ships at Point, Durban Docks. 80 ton crane in foreground.

Bluff

As one enters the harbour, the first wharves seen are those at the Bluff Coaling Appliances, but first there is a special landing point for whales, which are hauled to rail vehicles and taken to the whale oil factory on the seaward side of the Bluff. For the coaling appliances, there is a quay 2,365 feet long, with additional space for coaling whalers. Beyond are a dolphin berth to accommodate a 750-foot vessel with a depth of 42 feet at L.W.O.S.T., and three dolphin berths with a depth of 35 feet, each to take a 550-foot vessel.

At the Bluff Quay, with a depth of 30 to 35 feet, are the following coaling appliances, giving shipping capacities in tons per hour: One electric belt conveyor, 700 tons; two transporters, 150 tons each; one transporter, 400 tons, and one transporter, 700 tons—total, 2,100 tons per hour.

Trucks are off-loaded by three dumpers with capacities of 1,200, 700 and 400 tons per hour, the overhead storage bins having a capacity of 10,000 tons, and ground concrete bins 60,000 tons.

Island View

Beyond the dolphin berths are the extensive Island View oil sites, with a wharf 1,500 feet long, depths alongside from 30 to 35 feet L.W.O.S.T. Petrol and paraffin in bulk are discharged here direct into tanks, which number 61, with a total capacity of 47,750,000 gallons. Fuel oil is discharged at the adjacent dolphin berths.

Proceeding round the Bay in a clockwise direction, the next feature is Salisbury Island, formerly partly a pleasure resort, partly mangrove swamps, part of which was transformed during the war into a naval base. Behind Salisbury Island is a large area of mangrove swamps and mud and sand flats, largely uncovered at low tide.

Graving Dock

The next developed area, at the head of the Bay, is a group of basins and reclaimed areas forming, first, the floating dock erection basin constructed and used during the war; secondly, an Air Force Station for flying boats; then the Marine Airport, which has been used by the B.O.A.C. flying boats; and fourthly, the floating dock, length 350 feet, capacity 4,000 tons, and the Prince Edward graving dock, which has already been mentioned. This dock, with its length of 1,166 feet and depth on sill of 41 feet at H.W.O.S.T., can accommodate the largest ships afloat, with a very few exceptions, the limiting factor being the breadth at entrance of 110 feet. The dock can be divided into two compartments, the outer 678 feet and the inner 450 feet long, and is provided with one 25-ton crane, one 10-ton and two 5-ton cranes.

Maydon Wharf (Congella)

Turning at the head of the Bay and going back towards the entrance, this time along the northern side of the Bay, one travels along the long Maydon Wharf, in the Congella industrial area. The wharf is in several sections on different methods of construction, with a total length of 10,219 feet, the depths alongside ranging from 20 feet at the Whaler Wharf (where whale-catchers refit during the off-season) to 37 feet.

The wharves in this area are mostly not of the heavy construction found in the Point area and, therefore, are not suitable for cranes. There are, in fact, only two cranes at Congella. The wharves serve industrial sites and the handling of cargo is done by ships' appliances. This is an exception to the rule in South African ports, where cranes are usually provided in large numbers on all quays. Maydon Wharf is used largely for timber, grain and other bulk cargoes. Privately-owned facilities in this area include a conveyor for shipping manganese ore at the rate of 500 tons per hour, a 12-in. pipeline for shipping molasses at the rate of 280-300 tons per hour, and a 6-in. pipeline for discharging palm oil at 80 to 100 tons per hour.

The grain elevator is also situated at Maydon Wharf. It has a capacity of 42,000 tons, intake capacity and shipping capacity each 1,000 tons per hour. South Africa is normally a grain-exporting country, but during 1946 the elevator and the harbour and the other South African harbours have been called upon to land and handle great tonnages of grain, imported due to unprecedented droughts.

Floating Crane and Tug, Durban.

Point

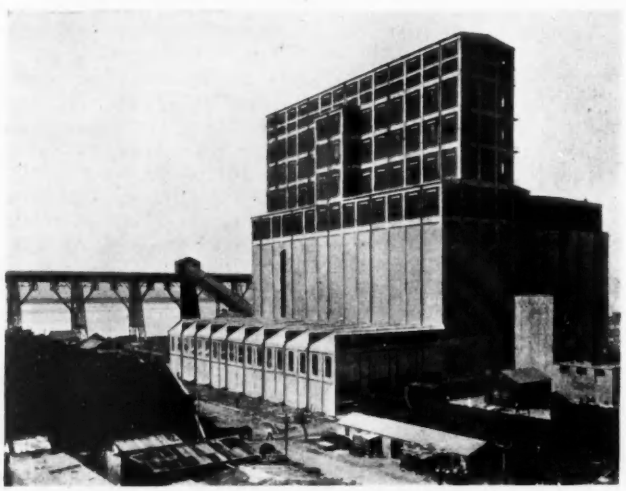
From Congella one traverses the deep-water dredged Maydon Channel, passing a considerable frontage on the Bay occupied by Durban City, and then one reaches the final and most important part of the harbour. This is the Point area, the first part of the harbour to be developed. The Wharf here was, prior to 1936, a long quay wall, straight except for one bend, with a length of about 6,500 feet. Then, however, the quay was extended and

Port of Durban—continued

at the same time the construction of the "T" Jetty was commenced. This jetty, which is actually a quay about 800 feet wide, provides berthage of 5,042 feet, projects into the dredged deep-water area, and has depths alongside of 36 to 40 feet.

The "T" Jetty was completed at high speed during the war, but only two sheds were built then, and it has still to be fully developed for handling cargo and passenger traffic. During the last 10 years, the wharfage at Point has been almost doubled and is now 12,417 feet, the depth ranging from 23 feet to 40 feet. The cranes total 88 and there are 35 electric capstans. The cranes are: 1 fixed electric, 80 tons; 6 of 10 tons capacity; 66 4-ton and 8 3-ton electric and 7 mobile petrol-driven cranes.

Modern quays in South African harbours are mostly of gravity type, of concrete blocks with mass concrete foundation and superstructure, but the "T" Jetty was built of concrete caissons floated into position and sunk.



Grain Elevator, Durban.

The Point Wharf includes a pre-cooling store with a capacity of 1,800 shipping tons. The sheds, practically all in this area, have a floor area of 965,611 square feet and cubic capacity of 8,690,499 cubic feet. Fuel oil bunkering facilities are available at the Point and "T" Jetty berths, and there is a floating crane of 25 tons capacity.

Tugs

Durban Harbour is rightly proud of its fleet of powerful harbour tugs. There are six first-class tugs, with gross tonnages ranging from 505 to 766, the indicated horse-powers being 1,891, 2,400, three of 2,600 and the largest of 3,597. These tugs are fitted with powerful salvage pumps, monitor and other fire-fighting apparatus, wireless telephone, direction finder, etc., and have performed fine feats of deep-sea towage. They are twin-screw craft, coal-burning, and this limits their sea endurance, so that it is intended to station an oil-burning tug at Durban, with greater range but still essentially a harbour tug.

The Future

The area of Durban Bay is 4,122 acres or approximately 6½ square miles at high water. The area of deep water is approximately 650 acres and fronting on it are wharves of a total length of 27,458 feet, with dolphin berths equivalent to an additional 2,950 feet.

The "T" Jetty scheme is still to be completed. Four large in-transit cargo sheds have been completed, one is nearing completion and two have still to be erected. The total floor area of these seven sheds will be 420,000 square feet, compared with the total of 504,000 square feet available in the Point area before work on the scheme was commenced in 1936. The scheme also provides for a total of 54 electric cranes of 4-10 and 15 tons capacity, many of which have still to be erected. Plans which are being formulated include a new and larger pre-cooling store for export fruit and a new passenger terminal on the "T" Jetty, to be arranged on the most up-to-date lines. Work has commenced on re-building and modernising a number of the older sheds on the original Point berths.

Durban Bay still provides great scope for future development. An area of 529 acres was reclaimed at Maydon Wharf about 1933, and it may be confidently forecast that a great deal more land will be reclaimed and more channels dredged as the progress of the port requires. Plans have been laid for the heightening or reclamation of 1,300 acres of land at the head of the Bay, and a portion of the work is already in hand to provide a site for new railway mechanical workshops. Land is also required for new railway stores, marshalling yards and a locomotive depot, and by electrical and industrial undertakings. To ensure that industrial development does not mean encroaching on areas of Durban Bay which may be required in the future for harbour development, and to ensure that the whole of the Bay area is developed in the best possible manner, the Government has appointed a Bay-Head Development Committee. The report of that committee will give the Railways and Harbours Administration a long-term view of the best lines of development and will help towards the continued progress and development of Durban Harbour.

Book Reviews

Conveyors and Cranes, by William A. Atherton, M.Sc., Wh.Ex., Roy.Ex., M.I.Mech.E., pp: 351, with nearly 300 illustrations and numerous tables, price 25/- net. Published 1947 by Sir Isaac Pitman & Sons, Ltd., London.

This work reflects a lengthy experience in the design and application of conveying machinery and cranes. It will be found easy to read and of practical interest. It is not in the nature of a catalogue, but is a technical treatise embracing as much of the topics treated as is feasible in a book of moderate size.

The first part deals, in considerable detail, with the mechanical handling of goods, in package form (including bags, baskets, and boxes) by means of conveyors, elevators and stackers. The second part gives full consideration to those types of machines employed for handling coal and other loose materials in bulk. Both mechanical and pneumatic grain-handling plants are dealt with at some length. The third part is devoted to a briefer treatment of several important classes of cranes; as used in heavy workshops, in shipbuilding yards, on dock quays, and in railway goods yards. Ship hoists and electric telphers also receive attention.

Although the book is mainly descriptive, yet it contains many tables and graphs, also capacity and power formulæ, and worked examples relating to all kinds of conveyors. It will, therefore be of service to draughtsmen engaged on design work, as well as to factory engineers and others responsible for the selection and application of conveyors in connection with a variety of large-scale industries.

Ports of the World, Edited by Sir Archibald Hurd, A.I.N.A., 1,065 pp., price everywhere, post free, 30/- net. Published by The Shipping World, Ltd., London.

This work originally formed part of "The Shipping World Year Book," but in order to include all the information it was desired to publish, it has been found necessary to separate the section formally known as the Port Directory of the World from the Year Book and produce it as a separate publication entitled Ports of the World. The contents have been entirely reset and re-arranged and are divided into two sections, one dealing with all but the smallest ports in the United Kingdom and Eire, and the second with Dominion and foreign ports. Information about each port includes position, authority, imports and exports, depth of water, tides, accommodation, particulars of docks, basins and graving docks, charges, pilotage, officials, etc.

PORT OPERATION

Part 2 (D) of a series of articles by A. H. J. BOWN, M.Inst.T., A.C.I.S. and Lt.-Col. C. A. DOVE, M.B.E., M.Inst.T.

(Continued from page 310)

Organisation (continued)

Police

Pilferage and theft are unfortunate characteristics of ports all over the world. In order to combat what students must never cease to regard as a serious problem, police are employed regularly in all ports.

Some ports, Bristol, Cardiff, Barry, Newport, to name a few, have their own uniformed police force. Others, such as Liverpool, Leith and Calcutta, employ the police of the town in which the port is situated and pay the town for the use of their services.

It is interesting to note that, in London, the Port of London Authority provide their own uniformed police for duty within the docks they administer; but the Metropolitan Police Force polices the River Thames despite the fact that the Port of London Authority is also the Conservancy Authority.

In Liverpool, where the docks on the north bank of the River Mersey run through Bootle and Liverpool, an arrangement is in existence whereby the Liverpool City Police provide police for the docks in both towns.

The Mersey Docks and Harbour Board also administer docks on the south side of the Mersey at Birkenhead, but these are policed by the Birkenhead force.

The policing of docks is a specialised business and where police are loaned from the town or city, arrangements are often made for the same officers and men to be employed regularly.

Plain clothes police are employed as well as the uniformed branch.

In addition to police, cargo watchers in some form or other are employed in practically all ports. But practice varies, e.g., in Liverpool the provision of cargo watchers devolves upon the Master Porters, in Calcutta, arrangements to watch cargo are made by the Commissioners; in London, much of it is carried out by shipowners.

Customs Authorities

Customs Authorities play a most important part in the organisation of a port. They are a Government Department whose main business is to collect the Customs Revenue and to prevent smuggling to avoid the payment of customs duties.

In this country the administration of the Customs and Excise is vested in a Board of Commissioners appointed by the Crown. This Board, which is presided over by a Chairman, includes a Deputy Chairman and three Commissioners, all of whom are Civil Servants.

The staff is organised into two parts: (1) headquarters and (2) ex-headquarters. The headquarters organisation, with which the average port operating man rarely makes direct contact, is divided into Secretary's Office, Solicitor's Office, Valuation Branch, Accountant and Comptroller's Branch, Statistical Branch, Chief Inspector's Branch, Inspector General of Waterguard's Branch and Chief Inquiry Officer's Branch.

The ex-headquarters organisation, with which the port operator usually works, is spread all over the country and consists of two separate services: (1) the outdoor service responsible for the assessment and collection of duties, and (2) the waterguard, responsible for the prevention of smuggling.

The outdoor service is divided geographically throughout the United Kingdom into Collections, the senior official of which is known as the Collector. Each Collection is made up of a number of Districts, each in charge of a Surveyor, who may be regarded as the "opposite number" of the port undertaking's Dock Superintendent. Districts are further sub-divided into Stations. A Station, which is controlled by a Customs Officer, may cover a wide area such as part of a dock, or a small area such as a warehouse, depending upon the duties to be performed. Customs Officers are assisted by Customs Watchers, who are employed under their supervision to patrol quays, bonded warehouses, etc., for the purpose of taking charge of goods liable for duty until they are in a place of approved security, and to check them when required.

The responsibilities of the Customs may be said to be: (1) accounting for all goods imported; (2) ensuring that they are not released until duty has been paid; (3) controlling goods and operations in Bonded Warehouses; (4) supervising the shipment of goods from Bonded Warehouse or on drawback ("drawback" is a refund of duty made on the exportation of goods previously imported); (5) enforcing import and export prohibitions and restrictions.

Checkers and members of delivery gang (dockers) delivering to railway waggon from loading bank.

The Waterguard Service or, as it is sometimes called, the Preventive Service, is divided into 15 geographical divisions, each under the control of a Waterguard Superintendent. Divisions are divided into Districts, in which the senior officer is a Waterguard Surveyor. These are further split into Stations, which are operated by a Preventive Officer, although Stations are organised into groups each under the control of a Chief Preventive Officer.

The duties of the Waterguard include: (1) the boarding of all overseas ships on arrival; (2) the control of ships' surplus dutiable stores; (3) examination and assessment of duty, etc., on personal effects and baggage of passengers and crews; (4) searching for concealed contraband: and (5) the supervision of coastwise and fishery shipping.

It is interesting to note that the Officers of Customs act for other government departments, as, for example, in the enforcement of Public Health Regulations for the Ministry of Health; the measurement of deck cargoes, etc., for the Board of Trade; the control of the landing of live animals for the Ministry of Agriculture and Fisheries, and performing certain Immigration work for the Home Office.

Port Operation—continued

Shipping and Forwarding Agents are firms to be found in all ports who undertake, on behalf of traders, to make all arrangements and complete all formalities, including Customs, connected with the export or import of cargoes.

Towage and Lighterage

Towage and Lighterage are normally in peace-time in the hands of private enterprise. Most port authorities, however, exercise considerable control by means of licensing, bye-laws, etc., and themselves own sufficient craft to deal with limited operations mainly concerned with their own business. In peace-time, lighterage is customarily limited to cargo destined for delivery by water conveyance or to heavy lifts, but in war-time, in order to

Shore gang (dockers) making up a set (right) on the "pitch" and docker pushing hand truck with cargo for them to load. 1 set being hoisted to ship by quay crane. 1 set made up ready for hoisting (left). Other shore gangs in the distance.

improve ships' turn round, much greater use is made of lighterage and it is used in circumstances which in peace-time would be regarded as uneconomic, mainly because of the extra handling and the additional cost and risk involved. Building extra craft tonnage is a lengthy and very costly business, for it means increasing towing power as well as lighterage. In order to minimise the necessity for this, to avoid wastage of lighterage space and to spread the risk, many port authorities during the 1939-45 war set up a pool of towage and lighterage facilities, which had the effect of centralising these functions under one administrative head in each port, who handled the tugs and lighters on behalf of the owners.

The consideration of lighterage raises the important question of the responsibility for the provision of labour in craft to receive and stow cargo delivered overside from ship or vice versa. Practice is by no means general.

In London the custom is for the ship to order craft and to supply the labour in it. With few exceptions, the lighterman takes no part in the physical handling of the cargo, his time being occupied in checking the cargo and in ensuring that he gets a good stowage or an efficient discharge.

At other ports, e.g., Bristol and Cardiff, the ship confines itself to inboard operations only in regard to over-side cargo, leaving the arrangements for the provision of craft and labour to the receiver or shipper.

A division of responsibility similar to that at Bristol and Cardiff, as between ship and shore, operates in normal times at Calcutta. There is a notable difference, however, in the source of the labour supplied for working in the craft. In Calcutta the stowing or discharging of craft alongside ships is carried out by the boat manghies (lightermen), usually four in number, who form the crew of the craft. (Lighters and similar craft are known in Calcutta as boats.) A deviation from this custom was made towards the end of the war, when considerable additional labour was placed in boats to assist boat manghies in handling awkward services stores, with the object of improving ships' turn round. It is interesting to record that the introduction of this temporary arrangement into a port where it had not been practised previously, elicited many different expressions of opinion on the subject of financial responsibility, as between ship and shore, for the additional expense incurred, from shipping and port operatives who had gathered in Calcutta for war duties from ports scattered all over the world.

Ship Watering

Ship watering, which has already been referred to, is sometimes carried out by the port authority and at other times by private enterprise. This latter case is particularly so when water is delivered from water boats and not from shore by hydrants. Some port undertakings, e.g., Calcutta, by sinking wells on their own land, have made themselves partially independent, but the general practice in this country is for all fresh water for ship watering to be supplied to the port undertaking by the statutory water authority in whose area the port or dock is situated.

Power

The two main sources of power supplied from outside agencies in ports are electricity and hydraulic. Although port authorities may generate their own electric power, it is more usual for them to draw it from local electricity undertakings. On the other hand, hydraulic power is more usually developed by port authorities and only rarely drawn from outside sources.

National Dock Labour Corporation, Ltd.

No chapter on modern Port Organisation can be regarded as complete without some reference to The National Dock Labour Corporation, Ltd. The National Dock Labour Corporation, Ltd., is a company formed at the instigation of the Government during the 1939-45 War, to provide dock labour for most of the ports in the country. Prior to the formation of the Corporation, employers usually took on and paid their labour direct, although an arrangement whereby wages were paid centrally was in operation in Liverpool as long ago as 1912. Under the National Dock Labour Corporation's present scheme, the Corporation provides and pays the labour and charges the employer with the wages of the labourers, plus a percentage for the cost of administering the scheme. It is not proposed at this stage to go into the general question of labour, except to say that labour registered under this scheme enjoys a form of decasualisation.

The Corporation is presided over by a Board of Directors, which comprises a Chairman, Vice Chairman and Finance Member, all appointed by the Minister of Labour after consultation with the National Joint Council for Dock Labour, three representatives of the employers and three representatives of labour, also appointed in each case by the National Joint Council for Dock Labour. The Corporation does not operate on the Clyde or the Mersey and associated ports, including Manchester, but similar organisations have been set up there by the Government.

Under a new scheme to be introduced shortly by the Minister of Labour and National Service, the above-mentioned organisations are to be replaced by one organisation covering the whole country, with certain minor exceptions, which will be discussed in a latter issue when the details become known.

Summary

Summing up, it may be said that although in general the functions fulfilled in ports are common to all ports, the organisa-

Port Operation—continued

tions responsible for operating them differ widely both in design and number. In many ports, organisations spring from customs and practices as old as the commerce of the port itself, which on examination often prove to be due to geographical or other peculiarities. Many of them have been evolved through the years by processes of trial and error, others are expedients dictated by circumstances; some, in the light of modern methods and knowledge, are obsolescent and outmoded, but their modernisation or re-organisation would often cause upheavals far beyond the immediate influence of the port and would probably bring hard-

Ships gear rigged to discharge to shore and overside. Crane also discharging to shore. Lighters alongside receiving or waiting to receive cargo.

ship in their train to established trades and communities. For these reasons alone, it is unwise to be dogmatic about differences in organisation and practice, and the student must be warned against generalising on port organisation. All ports, like all ships, are different and each one requires a detailed study before a valuable opinion can be expressed. The Transport Bill now before the House, to which reference has already been made, probably heralds important changes in organisation, and it is hoped that as a result of what has been written the student will be able to follow with keener appreciation the many points of view which will be expressed by the interested parties on both sides.

Part 3 (A)

Design and Layout

PORTS owe their locations chiefly to the safety they afford to shipping and the demands of trade. Most ports were in existence long before trade had reached its modern proportions or ships their present sizes. In consequence they have had to be developed by the provision of additional protective works; the deepening of approach channels; the provision of permanent deep water by enclosing docks, by pumping and by dredging; the building of entrance locks, quays, transit sheds, warehouses and dry docks and the laying out of dock railway systems and roads. It is with such matters as these that we are mainly concerned in this chapter.

Approach

The approach to a port from the sea must be navigable and clearly marked.

In most ports, whether they are situated right on the sea board, e.g., Alexandria and Sunderland, or a long way up a river estuary, e.g., London or Calcutta, dredging is necessary to maintain the required depth in the approach channel, either because of shoaling or silting, or because the draughts of vessels using the port have increased, with the passing of time, beyond the natural depth of water available. In some ports this may mean dredging right out to sea and in others long stretches of river are affected. London and Calcutta are two outstanding examples of large ports situated many miles from the sea which have been kept open to modern shipping only because the beds of the rivers by which they are reached have been artificially deepened by dredging. In both cases, consistent and regular dredging is necessary to maintain the river channels at their present depths.

Whether a port is reached directly from the sea or up a long river, the approach channel must be marked. Sea lanes and routes are, of course, charted, but the final approach to a sea port or river estuary usually requires additional marking. This is achieved by means of floating buoys fitted with lights, lightships, lighthouses and sound signals for use when visibility is

Port Operation—continued

bad. Where a sea approach presents few problems to navigators, bearing points only are necessary; but in places where the channel is narrow, liable to alter its course or suffers from other navigational problems, it must be accurately marked at frequent intervals. In the same way, all wrecks which constitute a danger to shipping must be promptly and clearly marked by day and by night, pending their removal. The same means are used for indicating channels and wrecks in rivers, in which, because of their comparatively confined spaces, great accuracy is necessary.

The provision and maintenance of buoys and beacons (lights) are important and onerous duties which fall on the various bodies already mentioned. It is interesting, therefore, to know how they are regarded by the people for whose use they are provided. For this reason the following extract from " Nicholls's Seamanship and Nautical Knowledge," a book written by Capt. Chas. H. Brown, F.R.G.S., for mariners studying for Second Mates', Mates' and Masters' examinations, is quoted: " Wrecks have occurred through undue reliance on buoys and floating beacons always being maintained in their exact position. They should be regarded simply as aids to navigation and not as infallible marks, especially when placed in exposed positions. The lights shown by gas buoys cannot be implicitly relied on, as, if occulting, the apparatus may get out of order; or the light may be altogether extinguished. A ship should always, when possible, be navigated by bearings or angles of fixed objects on shore and not by buoys or floating beacons."

Protection

The first essential in any port is that it should afford shelter for shipping. This is more likely to be a serious problem at a port on or near to the sea coast, e.g., Alexandria or Sunderland, than at a port which is many miles inland, e.g., London or Calcutta, where the estuary or river on which it is situated acts as a form of protection or buffer from the fury of the sea.

At ports on the coast with a long frontage exposed to the sea, protection is usually provided by flanking the port with two protecting jetties and building a breakwater parallel to the coast, between the jetties, in such a way as to provide two safe channels between the breakwater and the jetties for ships entering or leaving the port, as is the case at Alexandria.

At some ports sufficient protection from the sea is afforded by building the jetties themselves to act as breakwaters, without the aid of a detached breakwater running parallel to the coast. Sunderland harbour, for example, is protected by two granite faced piers, each over half a mile long, which project out from the shore into the sea in the form of converging curves.

In ports where the sea is not always too rough, the inner walls of the jetties are built in the form of quays, which provide berths for ships in favourable weather. When this happens, the jetties are built wide enough to provide road and rail access to the berths and with a high, strong wall on the exposed side to keep rough seas off the jetty.

Design and Layout

The design and layout of a port are determined by geographical position, natural contour of the land on which it has been built, hinterland, depth of water available at all states of the tide, rise and fall of the tide, trades catered for, value of the land, age of the port and preferences of the designers.

Probably the first decision to be made in designing and laying out a new port or dock, once it has been sited, is whether it is to be open or enclosed.

An open port or dock is one which is designed without any mechanical means of separating its docks or quays from the sea, river or lake on which it is situated. Such ports are to be found at Southampton, Glasgow, Alexandria, Port Sudan, Suez and Rangoon.

An enclosed port or dock is one which may be artificially separated by mechanical means, as required, from sea, river or lake. This separation is brought about by means of caissons, gates and locks as at London, Liverpool, Bristol, Cardiff, Newport, Leith, Sunderland, Bombay and Calcutta, and is known as " impounding."

In many ports, including London, Sunderland, Middlesbrough, Bombay and Calcutta, both open quays and enclosed docks are to be found in the same port.

Caissons are floating tanks which may be placed in position at wet or dry dock entrances and submerged when required. They are used for separating docks from approach channels, thus rendering wet docks free from the influence of the rise and fall of tidal waters. They are more usually used for dry docks, where they have the effect of sealing them off, so that the water in the docks may be pumped out after ships have been floated into them, for the purpose of effecting repairs or examination.

Two kinds of caissons are used for these purposes: (1) floating, which are independent units which can be floated to or from the entrance for which they are required; (2) sliding or rolling, which are permanently attached to ropes or chains, by means of which they may be drawn into a chamber cut in the side of the entrance, when it is required to float vessels into or out of the dock.

Lock gates, as their name implies, are gates which are hung at each end of an entrance lock, or where locks are not in use, at dock entrances. They are almost invariably hung in pairs. They are hinged to the wall of the lock or dock entrance. When hung in pairs, they form two sides of an isoceles triangle when closed. Each gate in a pair is known as a leaf.

The tops of caissons and lock gates take the form of gangways to allow the passage of pedestrians.

A lock is a narrow rectangular shaped chamber of water, large enough to accommodate a ship, constructed between the approach channel and the dock it serves, which can be partitioned off as required both from the approach channel and the dock. When the lock gates are closed at each end, the water level in the lock can be raised or lowered. This is done by passing water from the dock into the lock to raise the water level in the lock, and from the lock into the approach channel to lower it. For this purpose, culverts or sluice ways are built into the walls of the dock, the lock and the approach channel. Thus, by means of locks, vessels can be navigated from the dock to the approach channel and vice versa when the water levels are different.

The need for enclosing wet docks arises mainly from the desirability of keeping ships afloat at all states of the tide. The decision as to whether enclosing is necessary is governed by the following general factors: (1) the depth of water available at all states of the tide; (2) the depth of the approach channel at low water; (3) the size of ships using the port; (4) the range of the tide, i.e., the difference between the depth of water at high tide and low tide. Sometimes purely local conditions, such as exposure to heavy seas, fast rivers or heavy tides, play their part. In Calcutta, for example, very heavy, fast-running tides known as " bores," which operate during certain months of each year, cause a rapid rise in the level of the Hooghly, often amounting to as much as 16 feet in a few minutes. Whilst they are on, usually 4 to 6 days at a time, the river is rendered unsafe for the mooring or berthing of deep draughted vessels. During these periods it is therefore necessary to move any such vessels, anchored or moored in the river or at riverside berths, into the enclosed docks. The force of the " bore " varies from month to month. Accordingly, the Port Commissioners impose a draught restriction on vessels remaining in the river while this phenomenon is working, usually fixing it somewhere between 18 and 22 feet.

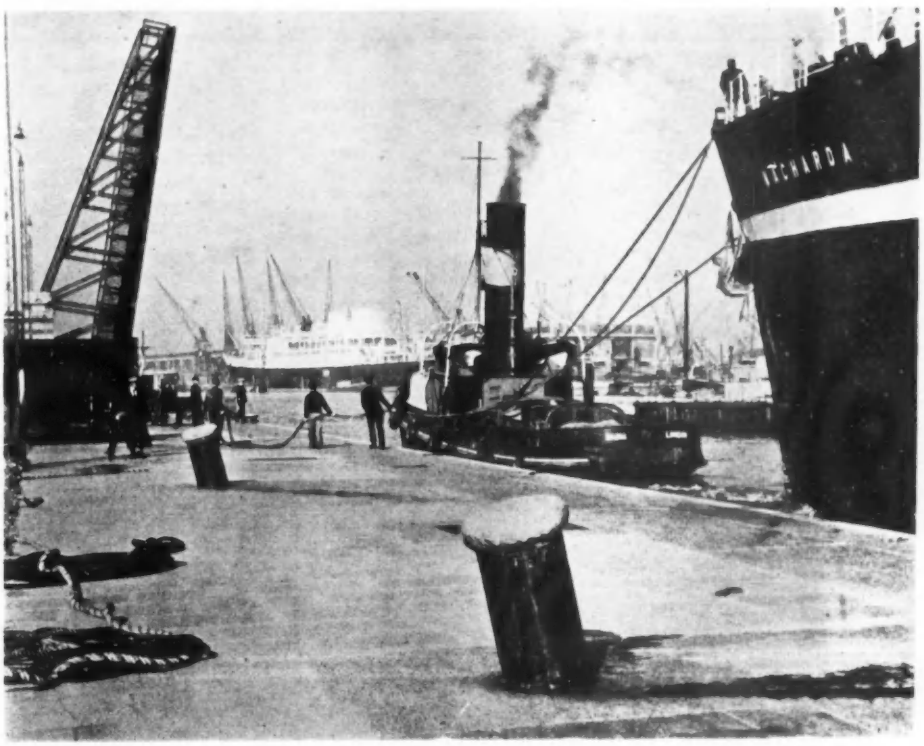
Gates, caissons and locks at entrances to wet docks are not necessary where the tidal range is small. There is practically no tide in the Mediterranean and, in consequence, there are no enclosed wet docks at such places as Alexandria, Port Said and Haifa. Southampton is another port which enjoys a low tidal range and has no need for enclosed wet docks. Glasgow, where all the quays are open, has a maximum range of tide of about 15½ feet and may be regarded by the student as a border line case.

The advantages of open docks are: (1) saving in the provision and maintenance of gates, caissons and locks; (2) saving in lock staff; (3) 24 hour accessibility to shipping, in tidal waters this would only apply where approach channel depths permit; (4) saving in power required to work gates, caissons and locks; (5) less delay in berthing ships due to absence of locks.

Port Operation—continued

The disadvantages of open docks are: (1) the depth of the dock water can only be increased by dredging. In enclosed docks, the depth of water can be increased by pumping in additional water from outside sources. (2) Additional cost of constructing quay walls to withstand variations in pressure caused by the differences between spring and neap tides and the daily rise and fall of all tides. This disadvantage does not operate in non-tidal waters. (Spring tide is the full tide at its maximum, neap tide is the full tide at its minimum.) (3) Exposure to rough water, although this can usually be overcome or minimised by breakwaters. (4) Necessity for adjusting mooring ropes, gangways and cranes with the rise and fall of the tides. (This point may be regarded as relatively unimportant, although it is frequently made, because adjustments are necessary even in static water, as ships become higher or lower in the water during the processes of discharging or loading.)

The siting of a dock entrance is a matter upon which a port undertaking requires the joint advice of engineers, pilots, harbour masters, dock masters, ship owners, small craft owners, lightermen and traffic staff. The engineers are concerned with the suitability of the terrain and the sub-soil of the site for the projected work; pilots, harbour masters, dock masters, ship owners, small craft owners and lightermen with the approach channel, the set of the tides, prevailing currents and winds and their effects on safe navigation, siltation and where locks are necessary, locking hours; the traffic staff are concerned with the position of the entrance in relation to operating berths and where it takes the form of a lock, locking hours. The result is usually a compromise, but in general the safe navigation of ships and craft in and out of the dock is the first consideration. The question of cost also arises, but this is a problem for the General Manager and his Board, and may be regarded as a matter for Port Economics and therefore outside the scope of this chapter.



Vessel passing into wet dock from entrance lock. Picture shows (1) Bollards set well back from quay, canted away from ship, with white tops; (2) lock edge marked white; (3) high lamp standards (extreme left); (4) lockmen carrying check rope; (5) lock gates in open position (right of tug); (6) tug has just taken lines from steamer to manoeuvre her to dock berth; (7) bridge (in up position left background) for vehicular traffic passing over lock.

Wet docks may be enclosed by means of one pair of gates only, as at Princes and Victoria Docks, Bombay, or a caisson, but it is most usual for locks to be used for this purpose. (It should be mentioned that consideration is now being given to constructing locks at Princes and Victoria Docks, Bombay.)

The use of one pair of gates or a caisson only, instead of entrance locks, is cheaper in capital outlay and costs less for maintenance, but since the main purpose of enclosing wet docks is to maintain as far as practicable a constant water level in the dock, such arrangements limit the time during which ships may be passed in or out to an hour or so each side of high water. It is obvious that if the dock were left open after the ebb tide had set in, water would run out and lower the water level in the dock to that in the approach channel. The student should be careful to note, however, that a greater depth of water could be maintained in the dock than in the approach channel by dredging.

By using locks (1) vessels may be entered or passed out at any state of the tide, provided there is sufficient depth of water in the approach channel; (2) the loss of water from the dock is limited to the volume required to raise or lower the level of the entrance lock when ships are passing through; (3) where the dock level is impounded to a higher level than the approach channel at spring tides, little of the additional water is lost when ships pass through, with consequent economy in pumping power (it may be said that little benefit would arise from pumping in additional water, unless locks were used); (4) where pumping is not practised, the benefit of the additional depth of water gained by opening the locks at spring tide can be retained for a longer period than if the dock were opened at each high tide, as is the case when single pairs of gates or caissons only are used.

In those ports where open and enclosed docks are to be found, open berths are normally used for coasters and the smaller ocean going vessels. Where, however, open berths are provided for larger vessels in the absence of a natural depth of water, dredging must be resorted to and the quay wall constructed to a greater depth. It is interesting to note that the drawings recently published of the proposed new docks at Middlesbrough show that they are to be constructed to keep ships afloat at all states of the tide on the open principle, although the existing docks are enclosed.

Where there is a likelihood of vessels resting on the bottom at low water, " hards " are constructed. A hard in this sense is a level area on the bed of the dock, abutting on to the quay wall, usually consolidated with timber baulks or other means of binding the area on which a ship may settle at low water, without her structure being subjected to the strain which might be caused by her coming to rest on an uneven surface. A disadvantage of allowing vessels to " sit on the mud," is that in the event of fire breaking out on board, they are liable to cause damage to transit sheds and quays, before the tide rises sufficiently for them to be floated away.

In some important ports where enclosed docks are used for large vessels, open berths are provided for large passenger liners in order to avoid the delay to passenger traffic caused by passing ships through locks. Such arrangements are rendered practicable by the peculiarities of passenger traffic, which make it unnecessary for vessels to lie alongside for lengthy periods. In London and Liverpool, tidal difficulties are overcome by the provision of floating landing stages in deep water, which are connected with the shore by large covered gangways which are free at the river end

Port Operation—continued

and, in consequence, ride up and down with the tide. The famous Ballard Pier at Bombay, which is also in open water, is, however, a static structure at which large liners can remain afloat at all states of the tide, which is equally successful for passenger traffic.

Size of Locks

One of the major problems confronting all dock designers is the tendency of port facilities to obsolescence, mainly due to the rapid development in the size of ships during the last half century. They are faced, therefore, either with providing facilities bigger than are required for known demands, thereby tying up capital against a contingency which may never arise, or providing facilities at an apparent economic cost to meet known requirements, which may become, suddenly and quickly, out of date. In no part of dock construction is this more marked than in the building of locks, for obviously their dimensions are very important factors in limiting the size of ships which may use the port.

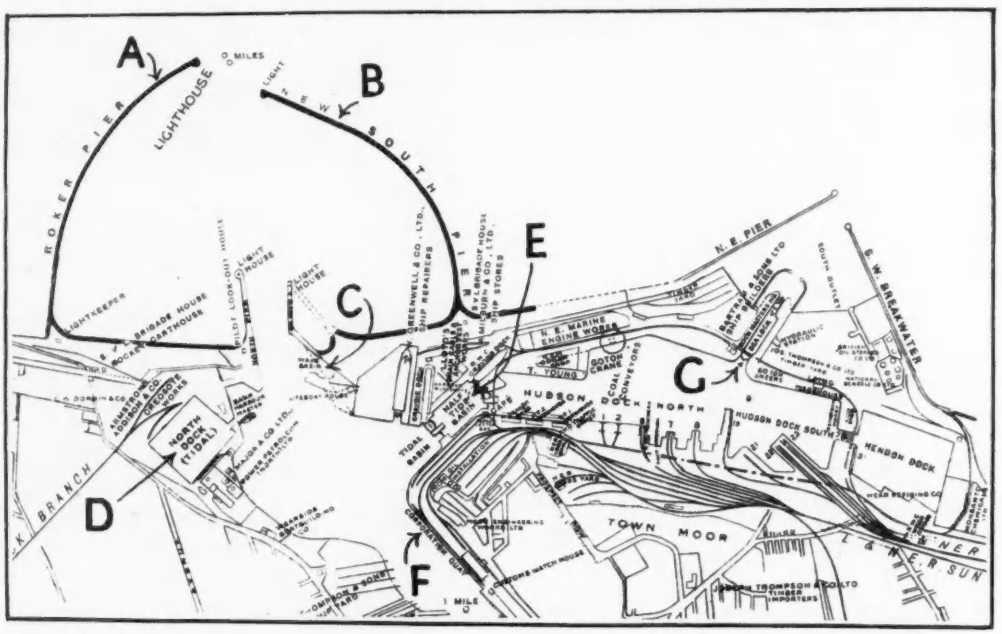
Before proceeding further, it should be explained that the measurement which governs the draught of vessels which can use a dock, is the depth over the sill. In general, it may be said that for safe navigation at least one foot of water is required between the bottom of the ship and the sill. (The sill is the raised ledge at the bottom of the entrance lock against which the leaves of the lock gates rest when the gates are in the closed position.)

The size of an entrance lock is governed by consideration of all the following factors: (1) the over all dimensions, i.e., length, beam (breadth) and draught, of the largest vessel in existence at the time of construction likely to use the lock; (2) the estimated dimensions of the largest vessel likely to use the lock during its anticipated lifetime; (3) the length of the periods each day during which locking in and out can take place.

The most important single issue governing the periods each day during which vessels may be locked in and out, in tidal waters, is the depth of the approach channel at all states of the tide. In some ports the tidal range is so great that at low water spring tides (L.W.O.S.T.), the tide runs right out, leaving the dock gates practically high and dry. The ambition of all ports is to provide sufficient depth of water in the approach channel for the passage of ships at all states of the tide; sometimes where this cannot be provided naturally, it can be accomplished by dredging. Where it is not possible to provide a 24 hour channel for large ships, it is often found to be practicable to do so for small craft and lighters, thereby leaving the lock free for use by large ships when the deep water is available, and also minimising the possibility of collision by clearing the approaches to the lock of small craft when larger vessels are coming through.

Where the period during which ships may be locked in and out is limited by natural causes, the drawback may be minimised by building a lock big enough to permit of a larger number of craft being dealt with at one locking. This also acts as an insurance against the consequences of rapid and unforeseen developments in the size of ships using the port.

It can be readily understood that the largest ship for which a lock may have been constructed may rarely use the port and, in fact, may only exist in the lock designer's imagination, with the result that a great deal of water is wasted each time the lock is not used to capacity. In order to limit this wastage, large locks



Plan of Sunderland Harbour and Docks, showing (A and B) granite faced piers (C) wave basin (D) open dock (E) tidal basin leading to half-tide basin (F) open deep water riverside berth and (G) entrance lock.

are normally constructed so that they may be divided into two unequal parts. This is done by the insertion of another pair of gates. Where the whole lock is not required for the movement of a ship or ships, the part which will cause the least loss of water is used. For many years dock designers have been anticipating ship development, e.g., The King George Dock Entrance, London, which is 800 feet by 100 feet, was opened in 1921. The largest ship to use it—or, indeed, any dock in the Port of London—to date is the Mauretania (772 feet by 89 feet beam), which first passed through in 1939. The biggest lock in London is 1,000 feet by 110 feet, which was opened at Tilbury in 1929, i.e., 228 feet longer and 31 feet wider than the largest ship which has yet used the port. An even more interesting example is provided by the lock entrance at Newport, Monmouthshire, which measures 1,000 feet by 100 feet and was first opened in 1914.

Power

Most lock gates are worked by hydraulic power, the machinery for which is housed on the lock side.

Protection to Lock Walls

Lock walls are often fitted with baulks of timber to prevent damage both to lock walls and ships' plates by contact and scraping as ships pass through. In some locks the baulks are fitted horizontally (above the high water level in the lock) and extend for the full length of the lock. In others they are fitted vertically. These timbers are known as rubbing bands. Experience has shown that both types are liable to considerable damage, more particularly the vertical variety, for that reason many dockmasters and ships master consider that the best protection to lock walls and shipes' sides, is provided by the use of fendoffs, lowered from the quay wall by the lock staff or from the

Port Operation—continued

ship by the crew. A fendoff, sometimes known as a "fender," is a cushion made of old rope, bundles of canes, rattans or similar substances.

Bollards

Bollards are fitted in entrance locks for the purpose of "checking" vessels through the locks. These bollards should be set as far back from the lock edge as possible and spaced at intervals of about 30 feet on locks used for small ships, and about 50 feet on locks used by big ships. In locks where ships are "checked" from the quay, the bollards should be given a cant away from the ship to prevent the turns of the checking rope from riding. Where checking is carried out on the ship, the bollards should be made with horns or lips to prevent the eye of the rope from slipping off the bollard. (Where ships proceed through locks under their own power, their progress is partially controlled by means of "checking ropes." Sometimes the ropes are made fast to the ship and adjusted or "checked ashore" as the vessel moves through the lock, when the reverse practice obtains the checking is said to be carried out "on board." The passage of vessels under their own power, with the aid of ropes and bollards, is called "warping." Check ropes are not the only means used for manœuvring ships through locks, sometimes tugs are used. It is largely a question of the practice favoured at the port. Dumb craft, i.e., vessels without motive power, are hauled through.)

Lighting

In tidal ports locking at night is inevitable, if serious delays to shipping are to be avoided, for the simple reason that in a normal two tide port high tide occurs at intervals of roughly 12½ hours each day, so that high tide time goes right round the clock in about a calendar month and therefore occurs as frequently by night as by day. In consequence, first-class lighting is an essential and important feature at lock entrances. Electric light standards should be located well back from the lock wall, so as not to foul ships' superstructures or impede the lock staff or others engaged on checking operations, but placed so to show up clearly the lock edges, which should be painted white. The tops of bollards should also be whitened.

Hailing Stations

Entrances to locks are used as hailing stations. For this purpose it is now becoming the practice to equip them with loud speakers, by means of which dockmasters can advise or confirm with ships masters and pilots as they enter the lock the number of the berth to which their ship has been allocated. The hailing station ensures that the tug masters and boatmen in attendance, get their instructions or confirmation of them at the same time as the ship's master and the pilot.

Buildings

The entrance lock should be equipped with a building suitable for offices and accommodation for the dockmaster, his office and lock staffs. Provision should be made on or near this building for a gear and old rope store. (Most lockmen are old sailors who, in addition to splicing and repairing ropes between the arrival and departure of ships, make fendoffs from old rope which has been condemned for normal use.)

Half Tide Basins

At some docks where there are entrance gates but no entrance locks, half tide basins, which have gates at each end, are used in much the same manner as large locks to increase locking in and out time. Owing, however, to the enormous amount of water required to raise and lower them, they cannot be used at all states of the tide, hence their name of half tide basins.

Tidal Basins

Tidal basins, i.e., basins which open direct on to the approach channel but are separated from the main dock by locks, have been constructed at some docks, e.g., Tilbury (Port of London), between the entrance lock and the approach channel. These basins provide berths for smaller vessels not requiring deep dock water and calmer water than is to be found in the approach channel in which to manœuvre ships into and out of entrance locks.

Turning Basins

In ports where the docks are too narrow to allow large ships to turn in them, as at Kidderpore Docks, Calcutta, turning basins are constructed for this purpose between the entrance locks and the main docks. At Kidderpore Docks the dry dock leads directly into the turning basin, thus providing more manœuvring space for vessels which, by virtue of repairs which they require, might be difficult to navigate in more restricted waters, and, in addition, keeping them out of the main dock fairway which is usually busy.

(To be continued).

Additional Reading.

Port Economics—Brysson Cunningham, Chapters I, II, IV.

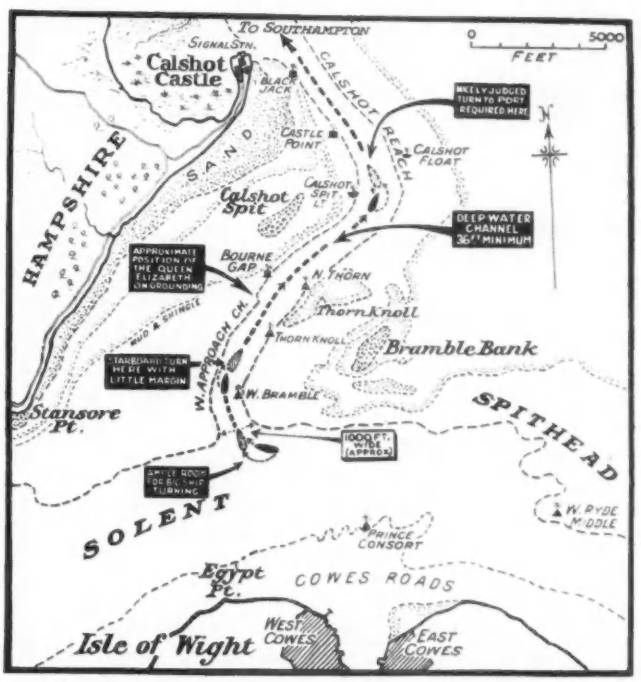
Dock Engineering—Brysson Cunningham, Chapters I, II, VI, VIII (General Principles only).

Dock Development—McElwee, Chapters IV, V.

Encyclopaedia Britannica—Docks.

Nicholl's Seamanship and Nautical Knowledge—Brown, Chapter XI, Pages 244-247.

Photographs on pages 9-11 are by courtesy of "P.L.A. Monthly," and the one on page 13 by courtesy of "Stanley."



Port of Southampton Approach Channel

Through the courtesy of the Proprietors of *The Daily Telegraph* we are enabled to reproduce above a chart of a portion of the Western Approach Channel to the Port of Southampton, which appeared in their issue of April 19th, and which serves to illustrate the account of the grounding of the *Queen Elizabeth* in our Editorial Comment on an earlier page. The chart shows the position of The Brambles Bank which necessitates for incoming vessels a sharp starboard turn into a channel which is at least 1,000-ft. wide with a charted depth of not less than 36-ft. at L.W.O.S.T. The draught of the *Queen Elizabeth* is stated to have been under 40-ft., and she was moving at a time when a depth of 45-ft. of water might have been expected in the channel. She went aground at a point just short of the Bourne Gap Buoy.

Notes of the Month

Dominican Republic Port Improvement.

A programme estimated to cost approximately $4,500,000 is planned for the improvement and dredging of the Port of San Pedro de Macoris. This port serves the most important sugar growing centre in the Dominican Republic.

Institute of Navigation President.

It is announced by the recently formed Institute of Navigation that the Astronomer Royal (Sir Harold Spencer Jones) has accepted nomination as president of the Institute. Air Chief Marshal Sir John Slessor and Sir Robert Watson Watt have accepted nomination as vice-presidents.

Minesweeping in Australian Waters.

The clearing of minefields along the East Coast of Australia will be completed by the end of this month. The naval authorities have cleared the minefields near Townsville, and a minesweeping flotilla, except for a few ships detached for work near Port Moresby, New Guinea, is now working near Cairns.

Port of Brest Repairs.

The commercial Port of Brest has now been almost entirely repaired, and is rapidly regaining its pre-war activity. It has not yet been possible to repair the graving dock, which is still blocked up by a large vessels which was scuttled by the Germans, but it is hoped one of the graving docks at the naval dockyard will eventually be made available.

L.M.S. Dock Appointments.

The London Midland & Scottish Railway announce that Mr. S. Rigg, superintendent at Goole Docks, has been appointed goods and dock superintendent, Wyre Dock, Fleetwood. Mr. H. Walton, assistant superintendent, Goole Docks, succeeds Mr. Rigg and Mr. H. C. Haberfield, chief inspector, becomes the assistant superintendent at Goole

Antrim Harbours Improvements.

The Piers and Harbours Committee of Antrim County Council is to undertake a new investigation into steps which can be taken to improve the harbours between Bengore Head and Fair Head, including Rathlin Island. Attention was drawn to the difficulties of transport to and from the island owing to the lack of a properly sheltered harbour.

Salvage Steamer for Liverpool.

A twin-screw salvage vessel to be known as the *Salvor* has been built for the Mersey Docks and Harbour Board by Ferguson Bros. (Port Glasgow), Ltd., and was launched at their shipyard at the end of last month. The vessel is 160-ft. in length and 34-ft. in breadth and will be fitted with triple-expansion engines of 1,300 h.p., giving a working speed of 12 knots. The launching ceremony was performed by Mrs. Beatrice Hart, wife of Captain H. V. Hart, marine surveyor of the Docks.

New Zealand Dockers.

Because of recent comments by Mr. Jordan, New Zealand High Commissioner in London, and from shipowners about the way New Zealand dockers handle ships, the national executive of the New Zealand Waterside Workers' Union has invited London dock workers to send a party of dockers to New Zealand to see for themselves what Dominion dockers are doing. The Wellington branch of the Union passed a resolution censuring Mr. Jordan for his disparaging remarks.

Improved Discharging Facilities at Port of Newport.

It is announced that the Great Western Railway Company are to spend £88,200 on improving facilities for the discharging of iron ore at Newport Docks. The scheme provides for six new 10-ton electric cranes and grabs, two electric capstans, five additional dollies, and the laying or relaying of track. At present at the East Quay, South Dock, 3-ton grabs are in operation and the new grabs of the level cut type, specially designed for bulk cargoes are able to handle 10 tons and will greatly increase the speed of unloading.

Northern Ireland Dock Labour.

It was recently announced in the press that the Committee of Inquiry into the decasualisation of dock labour in Northern Ireland, set up by the Minister of Labour, has completed the hearing of evidence and will render its report at an early date. The Amalgamated Transport and General Workers' Union has put forward the same proposal as in Great Britain that there should be a guaranteed week's pay for work or attendance.

Amplifiers for Liverpool Landing Stage.

The Mersey Docks and Harbour Board have approved the installation of an amplifier system to facilitate the handling of passengers and baggage at Liverpool landing stage. The work will cost £350, and loud speakers will be installed in the baggage room on the Princes Parade and at Riverside Station. The equipment will be so designed that further extension loud speakers can be added when and where required.

Limerick Harbour Development.

At a recent meeting of the Limerick Harbour Board, Mr. T. F. O'Sullivan, B.E., Harbour Engineer, said that the Board had schemes in hand to develop the port at an estimated capital outlay of £300,000. These developments included the erection of a new western entrance to the floating dock, a new entrance to the jetties, rail connection with C.I.E., erection of cranes on the south side of the docks and quays, the deepening of the river, and the building of deep-water jetties at the west end. The Port of Limerick, he continued, was not able to compete with its rivals owing to the absence of mechanical appliances.

Marine Radar in Canada.

Radar is playing an increasingly important part in the navigation of certain inland and coastal waters of Canada, and during the past year some 90 radar sets of the 268 type have been installed in vessels of Canadian registry. A large number of reports testifying to the usefulness of the equipment have been received by shipping interests whose ships operate among the narrow channels of the West Coast as well as the Newfoundland and North Atlantic areas. A radar set of this type has also been installed at Camperdown signal station, Novia Scotia, which overlooks the entrance to Halifax Harbour.

Navigational Aids at the Port of Hong Kong.

A report on the present position and future development of marine navigational aids and signal stations at Hong Kong, states that when the colony was re-occupied in August, 1945, it was found that all the principal stations had been bombed and looted and that most of the navigational lights had been destroyed. In view of the importance of these lights to shipping in the Colony, a special grant of £200,000 has been made by the Colonial Office for the purchase of new equipment. Also the opportunity has been taken to modernise the lighthouse system, and orders have been placed for new equipment. It is expected that the apparatus will be installed at the various stations within the next twelve months.

Improvement Plans for the Port of New York.

A plan to relieve congestion in the Port of New York by modernising cargo handling facilities and methods has been drawn up by the Commerce and Industry Association of New York. A recent investigation revealed that congestion is due chiefly to antiquated piers, averaging 40 years of age, and to a general increase in the volume of cargo handled. The Association recommended that new piers be constructed and that revenue from pier rentals be earmarked for interest and amortisation of the debt incurred for the new works. Construction should start at the earliest possible moment and study be given to the practicability of two-tier piers with provision for ramps or elevators to the upper level. The immediate programme should include strict adherence to a permit system to assure more efficient freight handling; closer co-ordination of the working of vessels, trucks and lighter deliveries, renovation of existing facilities and a traffic survey to investigate means of relieving congestion in the streets approaching the port.

The Costing of Dockside Traffic Operations

By J. A. PHILPOTT, A.L.A.A., A.C.I.S., A.M.Inst.T.

WHETHER it is a murder as in Macbeth, or the costing ot dockside traffic operations

"If it were done when 'tis done, then 'twere well it were done quickly."

There is significance still in "If it were done" for it is not yet the universal practice to quote new rates for handling dock traffic on the basis of cost plus profit, nor to test the efficacy of rates from actual results. There is undoubtedly good reason for avoiding the problem since most ports try to encompass within as few rates as possible the normal sequence of operations involved in exporting or landing and despatching cargo. The shipper and importer desire to know in advance if possible what port charges will be incurred on the goods in which they are interested and to consult a schedule of rates facilitates business for all concerned and not least that of the port authority. Nevertheless, conditions are constantly changing; sometimes it is the port authority and sometimes the merchant who considers that a particular consignment has special features which require an adjustment in the normal handling rates.

The schedule of rates has, of course, evolved from long experience and represents very broadly the cost of handling groups of commodities in a certain way. With such broad classifications as are adopted in practice some cargoes will show a profit and some a loss; this is inevitable even if only because of the enormous variety of goods dealt with, the manner of their stowing in the ship, the nature of the packing, such as boxes, bales, casks, barrels, bundles, bags or in bulk, not to mention the weather and the hundred and one things that can vary the output per man or per gang per day. Circumstances may change, but the rate must stand if not for ever, then as often as it can be made to serve. If the overall financial result is good then the management must take the rough with the smooth. But the management will not long be left in sweet content—the upward pressure of rising costs and the downward pressure of the whole mercantile community crying aloud for more service at cheaper rates will compress whatever surplus there is into a living space confined by an everlasting war on two fronts. There is a fight for revenue on one side and a battle against expenditure on the other. Good management demands that costs be at their irreducible minimum before an increase in port rates is contemplated. Thus we come to the need for a good costing system so that whether a rate is good or bad from the profit angle "the 'why' is plain as way to parish church." And, like Jaques, in "As You Like It," the accountant must have as large a charter as the wind if he is to mirror all that is good or bad in the financial effect of dockside operations. He must beware, though, lest it should be said that "in his brain he hath strange places cramm'd with observation the which he vents in mangled forms!" The difficulties of the traffic departments must be seen to be believed and having seen the accountant will report with sympathy and understanding the losses which grow where profits should be.

The rate applied to any particular traffic can be what the traffic will bear, the nearest appropriate rate in the schedule, or a quotation based on estimated cost. The first proposition is a matter of policy, the second commendable or otherwise according to motive, and the third wholly honourable but quite capable of making life difficult if carried too far. A policy rate can be expected to follow dismal tidings from the cost records as compared with competitive alternatives, and it may be that an examination of these records will show the way to make the rate a profitable one. However rates are decided, the efficiency of labour operations and of the mechanical equipment can best be assessed by watching carefully the fluctuations in the costing records.

To cost everything all the time and in complete detail can be an expensive process and one which, besides producing a volume of figures too great for the administrative digestion, lessens the value of the whole by causing it to be late. This can be avoided by making the system flexible so that any main element of cost can, for a period, be extended on an investigation basis without disturbing the main framework of statements produced. If, for example, it is found that the cost for delivery from sheds is increasing the usual headings of cost can be expanded from say five to twenty for a month or until the reason for the increase is located. A sequence of investigations of this kind is far more valuable and informative than a completely stereotyped set of routine statements. The latter are necessary for all standard headings of cost, but the system should allow any item to be broken down into a subsidiary analysis whenever required.

The degree of mechanisation, the kind of machines, and the volume of work all affect the precise methods to be adopted but there is nothing in the paragraphs which follow that cannot readily be adapted to the resources of a modern office. The minimum requirement is, perhaps, the usual non-listing adding and calculating machine. There is great variety also in the division of operations at the various ports as between the dock undertaking, the stevedores, and others and the sequence of services to be costed will differ accordingly. For the purpose of illustration let it be assumed that the dock undertaking will deal with the handling from and to the ship's rail and the discharging and stowing is carried out by the stevedores on behalf of the owners of the ship. Sometimes the stevedores will be contractors for the port authority. For the foregoing reasons the design of forms, accounts and diagrams is best left to the inventiveness of the individual accountant as no two ports have to contend with quite the same set of conditions and circumstances. Hence this article deals with the practical application of principles and not with sets of forms which must in every case vary with local requirements.

The field to be covered by the costing system will be that necessary to show:—

The profit or loss on the working of each ship.

The cost of all contributory services such as shunting, cranage and watering ships.

The results classified in trades, as say general goods, coal, timber, refrigerated produce, grain, feeding stuffs, tobacco, ores and any other type of cargo important enough to justify separate treatment for costing purposes.

The division of cost as between traffic and warehousing operations.

The aggregate cost in trades of all the sub-headings in the ship and other accounts.

The composition of accounts to be rendered on a job-cost basis. This is necessary when special operations are undertaken at the request of merchants or shipowners and which are not provided for in the schedule of rates.

With the results chronicled in these various ways which intersect and cross each other there will be presented a bird's-eye view of operational results from which most questions of administrative importance can be answered. They will provide also a valuable adjunct to the financial system with which the costing system is firmly integrated.

The complicated series of abstracts, schedules and summaries, the totals of which finally emerge in the published annual accounts of the undertaking, have their counterpart in a Budget Estimate of Revenue and Expenditure where budgetary control is exercised. In such cases the starting point for costing, as for the financial returns, is the Budget Estimate which can be a book of quite substantial proportions. Every page and every line has a reference which directly or by conversion can be incorporated in the code symbols used in the expenditure analysis. There is thus provided a standard by which to judge actual results and all fluctuations above or below this datum line call for examination and explanation.

Comparison with the Budget in such detail is only worth while if the estimates have been scientifically devised. The processes in compiling a Budget of this kind are:—

(i) Estimate under as many headings as possible the quantity of goods likely to be dealt with in a year. This implies the

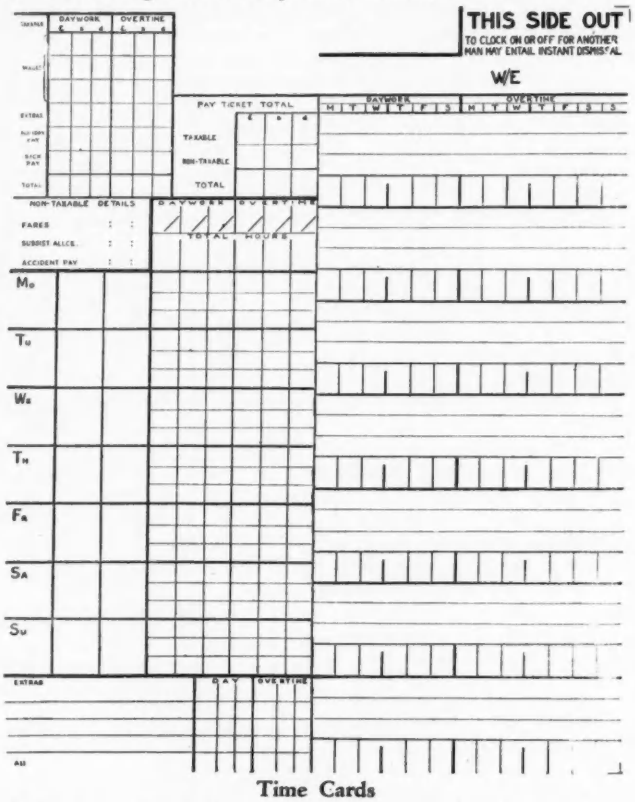
Costing of Dockside Traffic Operations—continued

availability of a complete schedule of commodities imported and exported during past periods.

(ii) Apportion these quantities over the various methods of handling, such as delivery to and from truck, lorry, craft, store and numerous other operations.

(iii) From costing records resolve quantities into outlay in wages, use of gear, establishment and profit.

All this involves a considerable amount of effort including a study of economic tendencies and trade practices, but there is justification in the knowledge obtained and in possession of a reliable set of figures. Not that the estimate will always mature—reality is far too fickle. The important feature is that differences indicate two very important things—which trades and which costs are fluctuating. If differences in quantities imported or exported could provide the whole answer one would not need to examine operations and costs but in practice a whole host of other interesting facts usually affect the net return.



Time Cards

Primary documents in a costing system are the clock cards and time sheets and with these must begin every labour-saving effort in the construction of costs. The labour force engaged comprises two classes—a weekly permanent staff and daily workers obtained from a dock labour pool. The former will usually clock on and off duty but the latter do not and the original document therefore takes a different form. Factory methods of job-costing are not wholly practicable for dock work where men are so widely scattered, perform varying jobs from hour to hour and with frequency move from place to place. It is, however, possible to devise a clock-card which also combines all the features of a time-sheet and to use it for the calculation of pay. It some ports, at least, the tendency is for weekly workers to be either key men or to have a constant type of job and in consequence the allocation of their wages to charge headings is not unduly complicated. Where these conditions exist, a time card of the folder type ruled as in the illustration shown above will prove extremely economical both in time and paper. It is suitable for either a punched card or a " slip " system. In the latter case a carbon-backed sheet is gummed to the time card and folds inside the card when placed in the card rack. When details of work performed are being entered by the timekeepers the sheet is folded over to the front of the card and the latter receives a carbon impression. At the end of the week this sheet is detached after coding, is guillotined along each thick horizontal line and provides a strip 1-in. by 4-in. which can be sorted according to its code symbol. These strips contain original information which enters immediately into the costing analysis without the further operations entailed in a punched-card system. The latter, however, has over-riding advantages in later operations where quantity justifies its use and where the same punched card can, after resorting, be used for a number of tabulations. The hand-sorted " slip " system will, however, prove efficient and economical provided it is used intelligently and with check totals at every stage. It is difficult to say when hand-sorting should give place to the mechanical punched card system; some would say never, as quite large volumes of work can be handled the former way. The advantages of the punched card are, however, self-evident where, as already mentioned, there are long runs, quantity, and the opportunity to use each card for more than one tabulation.

The left-hand side of the clock card shows the usual details of time worked and spaces for the calculation of wages, extras and other payments due to the worker. As, however, we are dealing with the costing system and not the wages system, the right-hand side is the part to observe in detail for the purpose of this illustration. Space is allowed for each permanent employee to be engaged on seven different jobs per week and where this does not suffice a continuation sheet can accommodate the remainder. The daily time spent on each job is entered in the squares below the description and each square corresponds to the day of the week shown in the heading and divided between day work and overtime. The thick vertical lines between the squares, two of which are broken, are aids to quick identification of the appropriate space to be used. The advantages of the combined clock-card and time-card are that accord between hours worked and hours allocated is assured, likewise the allocation of earnings, and apart from a saving of time through the absence of posting or copying, there is less likelihood of error in dealing with a single document which contains original entries.

Coding

After all wages calculations have been completed the next step is to code the entries on the right-hand side of the card. A whole age of tricks can be locked up in the code in order to make it at once extremely flexible, capable of enlargement at any point, temporarily or permanently, and simple and quick to use. A completely satisfactory code is probably one of the most difficult things to devise and should be developed with the costing system itself if it is to be successful. It is well worth while spending a great deal of time analysing past work before adopting a new coding system, first in order to see that all forseeable circumstances are covered and second, to ensure that each symbol gives full service without creating big blocks of waste letters or numbers. It will be seen, therefore, that the code should arise from the work it has to do and not be just imposed upon it. It will be affected also by the nature of the machines in use. Some, for example, require figure symbols only and others will permit a mixture of figures and letters although sometimes letters are feasible only in certain positions. Letters, of course, save space if the number of varients is more than nine but less than say twenty-two since all the alphabet cannot be used. One would, for example, leave out V or Y if the work is done by hand as confusion between these two is easy in hurriedly-formed characters, and coding is often done in a hurry. But it is asking for serious trouble to create a code in a hurry, and another reason for care is that once it is adopted it is the most troublesome thing in the world to change. One cannot be sure for how long atavistic tendencies will continue, but nature will see to it that the writ of exemption does not run here.

The coding done, the hours for each job have to be converted into money and entered in the appropriate space, day work and overtime being distinguished. This is a simple arithmetical job, the only debate being whether it shall be done on machines or otherwise. The experienced clerk with a ready-reckoner devised specially for the range of calculations peculiar to the job, plus his uncanny knack of writing down a large proportion of values

Costing of Dockside Traffic Operations—continued

at sight will probably beat the best machine made. Quantity and fatigue, however, are factors to be taken into account and apportionment between man and machine is likely to vary with the personnel available.

The work is now ready for punching cards or guillotining into strips. With an ordinary spring-board guillotine the latter operation is amazingly swift and one can look for speeds of between 6,000 to 10,000 slips an hour. (Very slow compared with punched-card sorting). It may to some sound primitive to have all these thousands of slips to be sorted by hand and then added on a calculating machine. If a piece of paper be lost or that lurking mischievous wind ever really swept across the sorting table, then one could indeed go all poetic and cry with Macbeth that "confusion now hath made his masterpiece." But in reality life is seldom coloured by this kind of tragedy and properly devised check totals not only prove the accuracy of the work, but make it easy to identify a missing slip if such there be.

No time need be lost in obtaining check totals; they can be obtained in the ordinary process of compiling the wages sheets or whilst check-adding the job allocations for each man to see that they agree with his total pay. If this latter work be done on a duplex adding-calculating machine sectional totals representing the pay of a number of men can be obtained automatically.

After being sorted to their code numbers the slips should be kept in their groups by small elastic bands, or after a final sort pinned by a stapling machine and given to the machine operators to total. To the skilled operator this process is practically as swift as columnar addition and the group totals are entered on specially prepared sheets for aggregation with the expenditure of other weeks in the same costing period. It is important to note that this work is concurrent with the preparation of the wages sheets and the final analysis should be completed at least by pay-day.

Exactly the same routine is followed for the daily workers except that the slips, if this method is employed, are made on a specially adapted listing-adding machine which will print amounts and code symbols in one operation. This difference in procedure as compared with weekly workers arises from the fact that daily workers do not clock on and off duty and the time sheets used as an alternative to clock cards are less adaptable to direct "slip" sorting. The speed of slip-making would vary with the amount of information required, but in round terms may be taken as 1,000 slips per hour. Where the men work together in groups as in ex-ship operations, the slip will represent the earnings of the gang on each operation, but whilst this economises in slips or punched cards, the work of breaking down earnings into chargeable items is much more complicated owing to the numerous extras that are paid in addition to the piece-work or time rates earned, and also because of the various minimum payments that enter into the wages computations. Incidentally, the wage structure of the dock industry must be one of the least desirable growths in a forest of industrial oddities. Something more equitable and better calculated to encourage efficiency and reward good work is long overdue.

Now that the method of producing the labour costs has been described we can turn to an examination of the results. These are dealt with in two ways:

(i) The sectional totals are aggregated with the results of past periods and build up the financial records of expenditure to date. They compare also with the provision made in the Budget Estimates.

(ii) The complete analysis provides the material for costing labour operations in infinite detail.

The total cost of landing and delivering would, for example, be a likely heading in (i), but in (ii), we should expect to find this expenditure analysed under ships and trades and a detail also of all the various classes of labour used in this operation. In ex-ship to truck operations there would, for instance, be recorded the cost of—

(i) Gang ex-ship direct to railway wagon or lorry;
(ii) Delivering through shed to wagon or lorry;
(iii) Weighing wagon loads;
(iv) Loading lorries;
(v) Roping, dunnaging or timbering wagons;
(vi) Trans-shipping to wagon or lorry.

Details such as these would appear for each class of commodity per ship, similarly for each of the operations of landing (a) ex-ship to craft, (b) ex-ship to store (c) ex-ship to quay, and so on for other main classifications. Exports would be treated in the same manner.

A re-sorting of slips or cards cannot be avoided where systems are used to the maximum advantage and in the case of punched cards this operation is so rapidly performed that it is one of the principal attractions of these machines. Nevertheless the procedures should be so devised as to reduce this operation to a minimum and it is surprising how, with care and forethought, a re-sort can be avoided. Repetition work can be avoided by creating slips or cards for sub-totals and sorting and adding these instead of the more numerous originals. This would be a suitable method for aggregating, say, the total cost of delivering through sheds for all trades and all ships, and similarly for all other items in the Ship Accounts where totals for cross-classifications are required.

The expenditure so far accumulated has excluded all items subject to apportionment such as chargemen, checkers, and hatchmen whose wages will frequently concern a number of commodities although relating to the same ship. These can be accumulated for each hold or for the whole ship according to the nature of the cargo and allocated to each commodity on a tonnage basis. This apportionment can best be dealt with in the Ship Account itself.

Output Calculations

Inasmuch as the aim is to arrive at a cost per ton for each class of goods the number of tons handled each day will be included in the information entered on the slips or cards. This can be available in the time sheets since it is the basis of the payments made to piece-workers, and most output to-day is on piece-work scales of pay. The method of arriving at weights for pay purposes is to divide the manifest or bill of lading weight by the number of units, be it barrels, cases, bags, packages or bundles and thus obtain a weight per unit. This is then the multiplying factor for the number of units shown to have been handled by each gang on the Checker's Return. The schedule of unit weights is prepared in advance and can be carried a step further. It can be weighted by the piece-work rate of pay, and the multiplying factor when applied to the output shown in the Checker's Returns will then give a product which represents, in shillings, the wages earned by each man each day. The first work of the day is therefore to add the Checker's Returns and convert them to amounts of pay. The whole of this work is a machine operation and can be swiftly done. The costing analysis can then be put in hand early on the same day. If this method is adopted the tonnage computation is deferred until the whole of the consignment has been worked and is one calculation based on the aggregated daily totals of the Checkers' returns instead of a daily calculation.

The analysis so far will have produced the direct labour cost for each class of goods per ship and including such items as "standing by" due to stress of weather, shortage of trucks, breakdowns and any other similar cause. There now remains to be added the cost of cranage, internal shunting, use of ship's gear, self-propelled trucks, and overhead charges. The information used has been taken from returns furnished by the timekeepers, checkers and hatchmen. The timekeeper has identified men, ship, holds, operation and commodity, but not weights or quantities. The quantity expressed in numbers and units is supplied by the checker together with marks, destination, name of consignee and the method of conveyance, i.e., truck, lorry or craft. The hatchman who is in charge of the hold gives the names of men in the gang and information regarding delays, breakdowns or any special incident affecting the work of his men. Under the conditions that exist on a dock one cannot have too many checks on the identity of men employed and it will be noticed that this information is supplied from two independent sources, namely the timekeeper and the checker. The three returns together have given all the information necessary to link up men with ships, jobs and goods. The extra operations of cranage, shunting, use of ship's gear and S.P. trucks have now to be considered.

(To be continued)

RADAR

Recent Developments for Use in Harbour Waters

By Captain H. V. HART, R.N.R. (retd.)
Marine Surveyor, Mersey Docks and Harbour Board.

FROM the earliest days of navigation, when mariners first attempted voyages out of the sight of land, constant endeavours have been made to improve the art of navigation by the progressive introduction of more precise navigating instruments.

During the last twenty-five years especially, and largely as a result of two world wars, developments in navigational appliances have been very rapid. The Gyro Compass has provided a valuable adjunct to the Magnetic Compass; the sounding machine, which replaced the old hand lead, has in turn been replaced by the Echo Sounding machine, and radio has provided most valuable navigational facilities in the form of directional wireless beacons, etc. In addition, numerous aids to navigation in the forms of "position" finding by other forms of radio activity have come into being, although not yet perfected, such as DECCA, GEE, LORAN, etc., until at last it may be surmised that the art of navigation has reached the nearest possible state to that of an exact science. It can never attain complete exactitude, but with the assistance of science, as near thereto as required.

All these improvements and developments, however, valuable as they doubtless are as contributing to the increased safety of navigation, fail to provide for one of the biggest problems of the navigator and one which constitutes an ever present danger in fact, i.e., collision, which has been the cause of the source of a large number of casualties in the past. Fog and its resultant danger of collision with other vessels, ice, etc., in addition to being a great source of danger, is also a factor of considerable delay to ships, and, prior to the introduction of Radar, no antidote to this risk has hitherto been found.

The general application of Radar, which will doubtless come —and very soon—will reduce this risk to an infinitesimal degree. What navigator does not remember at some time in his career "hearing, apparently forward of his beam, the fog signal of a vessel, the position of which is not ascertained, etc." (Article 16, Rule of the Road), and by the same Rule being then obliged to "stop his engines and navigate with caution," with its consequent anxiety to mind, danger to his vessel, and loss through delay to his Owners? Again, what of the occasions on which a vessel has had a "near miss" from disaster through *not* having heard another vessel's whistle, either through weather circumstances, carelessness on the part of the other vessel, or the imperfection of the other vessel's whistle? These headaches for the navigator are (or should be) now over.

"*Autre temps, autre moeurs,*" Radar supersedes untrustworthy sound signals, straining eye-sight, deafened ears and uncertainty in the mind of the user as to the problematical movements of the other vessel concerned, as her movements can be constantly observed by Radar, and the necessary evasive action taken accordingly.

What is Radar? It has continually been referred to in the Press as the "Invisible Eye"—a more accurate, popular title might perhaps be the "Reflecting Ear."

The following description of Radar is not intended to be in any sense technical and for a very good reason, which is that, if the writer attempted to indulge in technicalities, he would soon find himself in "shoal water," as he is quite without the necessary technical knowledge to describe Radar in anything but the simplest form, and moreover, as a seaman, is a firm believer in the old adage, "The gunner to his linstock, the helmsman to the wheel, and the cook to the fore sheet," and let it be added—the scientist to technical explanations.

Previous to the introduction of Radar, it was a common practice for the navigator to endeavour to obtain warning of the proximity of icebergs, high cliffs, etc., by the echoes from his ship's whistle and largely in the same way that the Echo Sounding machine gives warning of the varying depths between the sea bottom and the ship, so Radar may be compared with it in giving warning of the presence of all surface objects within a certain range of the vessel.

Briefly then, the principle of Radar is a method of producing echoes by radio instead of sound. Radar provides definite and accurate determination of the presence of objects which are the sources of such echoes and in its various development, in addition to providing against collision in fog, also provides a valuable means of position finding of a vessel.

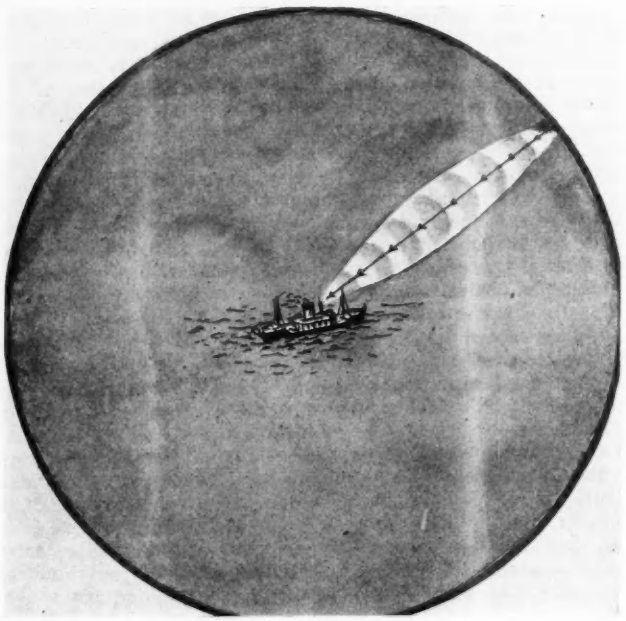


Fig. 1. How Radar Hears.

The principle of Radar consists of the propagation and radiation of a series of directive radio pulses in the form of a revolving beam. These pulses are of very short wave length and a very high frequency and are directed from the "scanner," known also by reason of its parabolic shape as a "cheese," on the vessel or station. On impact with any above water object within its range, the beam is reflected (echoed) into the "scanner" and thence translated through the receiver on to the surface of a Cathode Ray tube in the form of light. The speed of the reflection or echo is that of the speed of light; the indicator or dial (P.P.I.) is the means of portrayal to the navigator of the presence of other above water objects within the range of the instrument.

Fig. 1 shows pictorially the propagation of the radio pulses and their reflection or echo from the object back into the "scanner."

The whole Radar installation is divided into four separate units, as follows:—

1. Aerial Unit.—This comprises the aerial antenna and its associated units.
2. Transmitter Receiver (T.R. Unit).—This again includes several associated units.
3. Console.—This includes a Receiver, Plan Position Indicator (P.P.I.), Control Panel, Power Unit, and forms the main unit from which the set is controlled and presents the display of the information by Radar.
4. Motor Generator Set or Alernator Unit, which forms the source of electrical supply to the equipment.

Radar—continued

It is now proposed to give a more detailed description of these maint units, but in doing so it must be pointed out that this description is of a set of a composite nature comprising details of the various designs of different makers, and, as such, should be accepted under the principle of " different ships, different long-splices."

The technical side of the set is entirely omitted for reasons already stated above and also because the " man in the street " is principally concerned with " performance," i.e., what Radar does and how it does it.

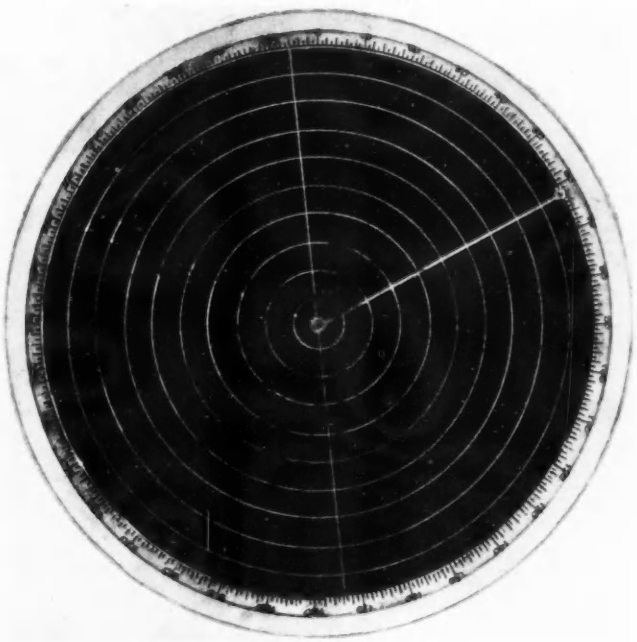


Fig. 2. How Radar Shows.

1.—Aerial Unit

The " scanner " is about 3 to 4 feet in width and of an approximate weight of 300 lbs. and can be fitted either at the masthead or above the bridge. In some sets this " scanner " is fitted inside a water-tight dome or " perspex," which is fitted above the bridge.

The " scanner " is driven by a motor at approximately 30 r.p.m. and provision is made for heating and de-icing, so that its operation is efficient in all weathers.

The maximum wind velocity allowed for efficient operation is 70 m.p.h.

Objects remain visible to a maximum roll of the vessel of about 15 degrees.

2.—Transmitter Receiver (T.R. Unit)

This unit contains most of the apparatus and should be situated in the vessel as nearly as possible in a vertical line below the " scanner."

3.—Console

This is normally fitted on the bridge and in or near the chart-house, as it is from this unit that the navigator obtains his information. The longitudinal distance between the " scanner " and the console is limited to about 60 feet.

The display unit or P.P.I. presents this information on the screen of a Cathode Ray tube, on which all surface objects within range are reflected in the form of a " spot " of light.

From the centre of the display, which is, of course, the position of the ship, a faint line or " trace " of light revolves around the screen, synchronised with the rotation of the " scanner." When an echo is received, the light is intensified, producing a " spot " of light which represents the position of the object in bearing and distance relative to the centre of the screen. The special luminous coating on the surface of the tube continues to glow for some time after the spot of light has been " painted," so that the object remains visible during successive revolutions. By this means, not only a single object but an entire coastline remains continuously discernible.

In interpreting the " picture " which appears on the screen, it must be appreciated that only those objects which present surfaces such that they will reflect the pulses will be shown. Thus, in the case of a coastline consisting of, say, a sea wall fronted by a long stretch of sand between high and low water marks, at low water only the line of the sea wall will appear on the display, as the flat sand surface, though it may be half a mile in extent, will not reflect pulses back to the " scanner."

Calibration pips are generated in the set and appear as equidistant spots of light on the revolving " trace " line and therefore " paint " as concentric circles.

The spacing of these circles is usually either 1,000 or 5,000 yards, depending upon the maximum range of the scale in use.

Over the surface of the tube is a moveable perspex sheet on which there is a hairline cursor which can be rotated by hand, with a bearing scale marked in degrees round the edge of the display. In order, therefore, to determine the exact position of an object shown on the display or, alternatively, the position of the observer from an object, it is only necessary to rotate the cursor until it cuts the centre of the light spot, when the bearing can be read from the outer scale, and to estimate the distance of the object by means of the concentric range rings.

A more accurate method of ranging is also provided, termed a " range strobe." This appears as a concentric circle on the display and its diameter is variable, being controlled by a small hand wheel. The hand wheel is rotated until the strobe line cuts the centre of the object, when the range in yards appears on a dial alongside the hand wheel.

The dimensions of the console vary according to different sets and from general dimensions of approximately 2-ft. 6-in. by 2-ft. by 1-ft. to 6-ft. 6-in. by 2-ft. by 2-ft., but in general these dimensions will be found adaptable for installation in the chart-room or similar small adjoining space.

Fig. 2 shows the set-out of the display or P.P.I., which is shown as set to the 10,000 yard range scale. The line of light revolving from the position of the ship at the centre of the display reflects an object (a ship) on the top right-hand side of the display. The white line on the right indicates the cursor or hairline. The concentric circles on the display are at 1,000 yard intervals, and the degrees of bearing are shown on the edge of the display. For convenience, this diagram is shown at a reduced size of the usual size of the display, which is 9 inches.

Fig. 3 shows a portion of the River Mersey in " paint," as it would appear during the intervals between the rotations of the " scanner." From this diagram, it will be seen that both coastlines of the river, with all the salient features thereto, are plainly and continuously visible and available for fixing a ship's position.

So far, then, we have arrived at the point where an object is reflected into the display and represented as a " spot " of light, and where the bearing and distance of such object can be determined. The dimension of this " spot " will enable the observer, within bounds, to discriminate between the size of the various objects reflected, such as large vessels, small craft, buoys, etc., and it will be found that ability to discriminate more definitely will improve considerably with practice.

Snow, sleet or rain do not materially affect results, although some deterioration can be expected under these weather circumstances, and particularly so during heavy tropical rain storms.

In rough sea, echoes will be returned from the waves, causing " sea clutter." These produce a large number of small, faint echoes, but since they seldom " paint " twice in the same position, the trained operator can readily discriminate between such echoes and those received from a more solid object, such as a ship.

Buoys, and especially those of conical shape, are not usually distinguishable beyond a limited range of approximately 4,000 yards. To increase this range, buoys will be fitted with a form of " reflector," either as a top mark or by the alteration in shape

Radar—continued

and extent of the buoy superstructure. Conical buoys so fitted are then rendered visible up to a range of about 8,000 yards.

The display is not limited to a single unit, as a second one can be fitted in any position at a reasonable distance from the first, which, for instance, will include both chart-room and bridge of a vessel. Displays can be either vertical or horizontal. The accuracies of range and bearing are as follows:

Range by estimation, using the " calibration rings " within plus or minus 5 per cent. of the maximum range of the scale in use and with the range strobe plus or minus 1 per cent.
Bearing plus or minus 1 degree at the edge of the display.
Small objects can be distinguished if separated by 3 degrees of bearing or 100 yards in range.
Minimum visibility of the set: 50 yards.
Minimum accurate range: 150 yards.

The displays are on three separate scales, i.e., of approximately 10, 3 and 1 mile ranges, the two latter giving increased expansion of scale and better discrimination of objects, and these are controlled by a hand switch.

A recent development and one which will prove a great utility to the navigator is the arrangement by optical reflection by which the image of the P.P.I. is superimposed upon the chart on the chart table in front of the display, termed a " chart comparison unit." This arrangement needs the addition of special cartographic features upon existing charts and it will, therefore, be some time before this additional facility is in universal use. This arrangement facilitates rapid plotting of the ship's position and relative position with regard to other objects visible in the display.

A feature included in some sets is " Azimuth Stabilisation," by which the top of the display is constantly directed to the north by means of a compass repeater unit. This will also be found a great advantage to the navigator when reading the display.

When reading the display, and particularly in the case of a remote display situated on the bridge, etc., it will be necessary to exclude all daylight, and for this purpose it is advisable to provide some form of cover. The best method is to fix over the face of the display a tube, blackened on the inside, of about 12-in. diameter on the display end and narrowing to about 6-in. on the outer end, over which a rubber eye-piece or mask is fitted.

4.—Motor Generator Set or Alternator Unit

This is situated in the engine room or in any other compartment within a specified distance of the console, usually not exceeding 250 feet. The current consumption required is from 2 to 5 kilowatts.

Value of Radar in Coastal Waters

Although Radar was probably originally designed and developed for the primary purpose of observing, and with the consequent ability to " range " upon surface objects, which fulfils its main function to seamen, i.e., the avoidance of collision in fog, it also fulfils a long required want of a valuable means of position finding in fog in coastal waters. Well recognised forms of land and navigational marks, such as light-houses, etc., can be defined and either single bearings and distances or cross bearings can be taken of such marks, and the mariner will, irrespective of weather conditions, be able to navigate in coastal waters with a confidence which he lacked before the advent of Radar.

Forms of Radar Beacons or " Responders " are being developed and will, no doubt, be fitted at certain important light-houses, light-vessels, etc., as the use of Radar in merchant ships becomes more general. These " Responders " would produce a characteristic form of echo on the P.P.I., rendering the identification of particular navigational marks certain, which is not always possible, as for instance, when a light-vessel some distance from the coastline has several other vessels in the vicinity, all of which would show similar echoes on the P.P.I.

Criticism will no doubt be raised on the question of the difficulties of operation and maintenance of a Radar set. In reply to this, it may be stated that during a 15 months' period of installation of an obsolescent 268 set in one of the vessels of the Mersey Docks & Harbour Board, it has only been found necessary to call in expert assistance on two occasions. During the whole of the above period, a 3 days' course in Radar was found sufficient for the officers of the vessel to successfully operate the set.

The Admiralty have instituted three weeks' courses in Radar and this should be quite sufficient for any intelligent officer to become quite confident to operate and to deal with any small defects in the set.

Makers of the various sets are also instituting maintenance at most of the principal ports at home and abroad, and this service will come into operation by the time that Radar installations in vessels have attained frequency.

Fig. 3. Part of the River Mersey as seen on the P.P.I.

The cost of the new standard sets is in the region of approximately £2,500, plus £500 for installation and fitting.

The potentialities of Radar for ships have been already realised, but have not hitherto been equally realised with regard to the application of Radar to a Port Authority.

Shore Radar Installations for Harbour Authorities

The Mersey Docks & Harbour Board were early alive to the great advantage of Radar for port use and have decided to adopt a new type of Radar for use in Liverpool. This type is something entirely new and has been especially designed for the purpose, as a " Harbour " installation, and contains many essentials not required in the ship-borne set. These include:

More definite discrimination.
Increased scale of general displays.
Expanded displays of certain areas with traversing sectors for same and for which off-centred P.P.I.'s are required.

Radar—continued

In designing this particular installation, consideration was given not only to the exact requirements of the Port of Liverpool, but to include as far as possible the probable requirements of other

Fig. 4. Diagram of Liverpool Bay.

similarly geographically situated ports. Briefly, ports may be considered to belong to three different categories, viz.:—

1. Those situated on a river or estuary and having long approach sea channels thereto.
2. Those situated on a river estuary or sea-board and having short approach channels thereto.
3. Those situated on the sea-board without approach channels.

It is obvious that the requirements for the above ports of various characteristics will differ considerably.

The ports in the first category will probably require the full " Harbour " installation which is, however, a costly matter.

The ports in category (2) will probably require an improved form of the latest ship-borne set. This improvement will take the form of the addition of an expanded sector of short range, which can be traversed in bearing so as to be able to examine any sector within an appropriate range. Greater discrimination will also be required by the use of a larger aerial.

For ports in category (3), the new ship-borne set will probably be sufficient.

The requirements of the Port of Liverpool are particularly onerous, as they include required displays of:

1. **Liverpool Bay,** extending to a range of 20 miles on a reasonable scale for recognition of all vessels entering that area, and discriminating between such vessels and navigational floating marks.
2. **Sea Channels,** extending to a range of 14 miles, in sections, and on a greatly expanded scale sufficient for identification of positions of all floating sea marks and determination of positions of vessels navigating these sea channels.
3. **River Mersey,** on a reasonable scale to fulfil, in a minor degree, the conditions outlined for the sea channels.

The value of a shore Radar installation to a Port Authority would be very great. Contrary to the usual idea, it is unlikely that it will be used for any form of " control " of shipping, although it *can* at any time be so used, and would be of the greatest value under exceptional circumstances.

It will probably principally be used for observational and informative purposes, and by this will ultimately effect a considerable saving to the owners of vessels making use of ports so equipped. Its utility in this respect is closely linked with the use of portable R/T sets, as already supplied to the Liverpool pilots.

Its principal uses are as follows:

1. It will enable port officials at all times to observe the movements of all shipping within the area of the port or the immediate approaches thereto.
2. It will enable a Port Authority at all times to observe and check the positions of all navigational sea marks within the port area and the approaches thereto. In cases of such navigational marks being off station, the Port Authority will then be in a position to immediately advise shipping if such casualties constitute a danger to navigation, etc.
3. Any casualty to shipping occurring within the area of the port or approaches thereto can be instantly observed and the necessary steps taken at the earliest possible moment to render assistance.
4. It will afford a valuable means of assisting vessels in calibration of their directional wireless. If, owing to thick weather, such vessels are unable to fix their exact position when calibrating, their position with regard to the position of the Calibration Station can be given to them.
5. It will afford valuable information to Pilotage Authorities and to pilots:
   (a) In thick weather, pilot boats, which do not habitually cruise outside the area of a port, can be advised of the approach of all vessels which will require pilots.

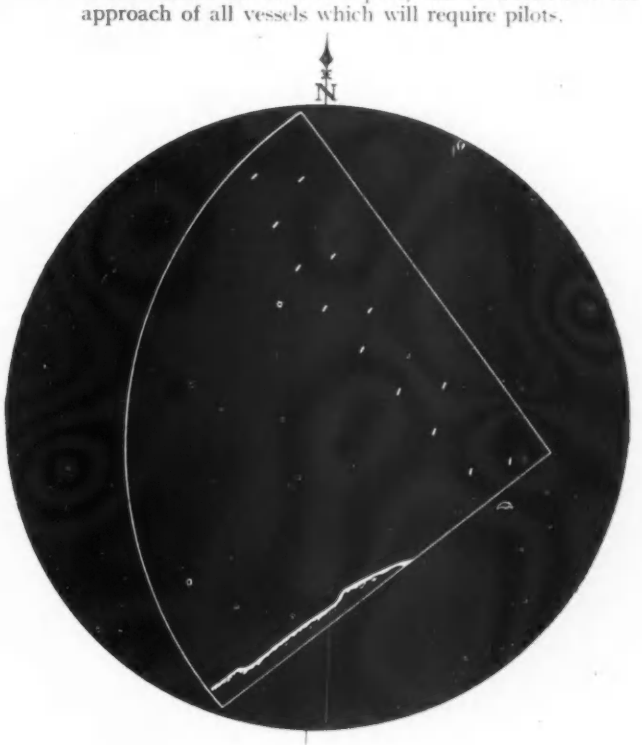


Fig. 5. Section of Channel, Liverpool Bay.

(b) In thick weather, the pilot of an inwardbound vessel may be dubious as to the advisability of entering the channels leading to a port or to the port itself in the absence of knowledge as to other vessels undocking or at anchor therein. This information can be given to him and may result in the saving of a tide to the vessel.

Radar—continued

(c) Pilots of vessels desiring to dock or undock in thick weather desire to know that state of the area immediately adjacent to the dock with regard to other vessels, and the necessary information relating thereto can be supplied.

6. The Port Official responsible for docking vessels can be informed of the latest movements and positions of inwardbound vessels, which will enable him to gauge the prospects of the dockings on the next tide.
7. The Port Health Officer will be able to be better informed as to the movements of all incoming vessels.

In connection with the utility of Radar, as already experienced in Liverpool, the following two incidents as having occurred in connection with the 268 set installed in one of the Board's vessels may be mentioned:

(a) A wreck buoy in the River Mersey was fouled in a fog by a vessel and reported as out of position. Owing to the weather, it was unable to confirm the position of this buoy, but the Radar of the Board's vessel, lying alongside the stage, showed that the buoy was 500-ft. out of position, and shipping was warned accordingly.

(b) During dense fog, a floating mine was reported off the Bar and the Board's vessel was able to proceed out by means of her Radar (which would otherwise have been impossible), locate the mine by Radar, and destroy it.

The special " Harbour " Radar installation, as planned and under construction for the Mersey Docks & Harbour Board, will consist of the following:

The installation will be sited on the river wall at the mouth of the River Mersey, giving a complete view of Liverpool Bay, comprising the sea channels to the approach to the port and the greater portion of the river itself.

The aerial, which includes a " scanner " of very large dimensions, will be mounted on an 80-ft. tower.

The Console will be housed nearby and provide five separate displays, each employing a 12-inch diameter Cathode Ray tube. The whole area is shown on a general display of 13 miles range, with a switch to an extended area of 20 miles.

All displays have an off-centred P.P.I.

The remaining displays are expanded sectors showing certain areas of the sea channels on certain arcs of bearing and of varying ranges, and these arcs can be traversed in bearing so as to be able to examine any part of the area within the appropriate range.

Fig. 4 shows a reduced-size display of Liverpool Bay at a 13-mile range.

Fig. 5 shows a reduced-size display of a section of the sea channels in Liverpool Bay over an area of 3 miles.

Means are provided for directly comparing the display with a reproduction of a gridded chart, by means of a transparency superimposed upon the display. By this means the positions of all buoys in the sea channels can be instantly checked.

This installation will normally be operated by non-technical operators, who will also be required to operate the R/T installation and the installation for use with portable wireless sets, which are already in extensive use in this port.

The method of relaying the necessary information to the Board's Headquarters will, in the first instance, be performed by ordinary direct land telephone, but in planning this installation, provision is made for relay by television in the future.

The potentialities of Radar are very great and of varied character as applied to users other than those in sea-going vessels. Initial prejudice from certain old-fashioned quarters will doubtless exist, as in the past, with regard to all improved navigational devices, on the plea of decreased caution on the part of the navigator. These prejudices will, no doubt, be quickly dissipated and relegated to the limbo of the past as soon as the advantages of Radar to the user become more widely apparent in the form of increased safety, and consequently quicker passages to vessels so equipped, and with decreased delay in entry into and departure of vessels from ports which are equipped with Radar installations.

Much interest has already been aroused and many enquiries have already been received from ports outside the United Kingdom with reference to the plans and progress of the Liverpool installation. There is no doubt that the initial demonstration and operation of this installation, when complete, will be attended by representatives of Port and Harbour Authorities from all over the world.

In addition to the use of Radar by these Authorities, there will doubtless also be a demand for Radar, either in the form of a ship-borne set or of an expanded nature, to meet the requirements of ferries operating in areas also made use of by other shipping. By the use of Radar installed either in the boats themselves or on certain places of landing and embarkation used by them, the safety of passengers will be materially increased. Indeed, in the River Mersey this scheme is already under project by one of the Ferry Companies operating an extensive service.

Every facility is being given by both the Ministry of Transport and the Admiralty to the perfection and general introduction of Radar, and scientific committees have been established to define certain definite specifications under which new sets should be constructed by the various commercial firms concerned, with a view to providing all the necessary required facilities and requirements.

Owing, however, to the universal shortage of materials of all descriptions, the number of modern sets yet available is strictly limited and several months will elapse before a reasonable flow of these sets become available for general use.

It is anticipated that, in the near future, Radar will become the normal equipment of every well-found vessel and will prove one of the greatest blessings ever contributed by science to modern navigation.

It is hoped that the foregoing brief and elementary description of Radar will afford the reader, who may be quite unversed in knowledge of this subject, some insight into its performance and the various navigational uses in which it is capable of operation.

Proposed Port for Tanganyika

An East African Development Scheme

Excerpts from the Report of a Mission sent to investigate and make recommendations on the suitability of certain sites for the construction of a deep-water port required primarily for the shipment of groundnuts grown in the Southern Province of Tanganyika Territory.

General

There is no port in the Southern Province worthy of the name, and no railway at all. Only very primitive road communications exist from the coast to the area which it is proposed to clear and cultivate, and these roads are only suitable for light traffic for a part of the year. During the rainy season (December to April), roads are liable to closure.

It was clear to the Wakefield mission (the composition of which is given in an Editorial Comment), that a new port with quays for deep-draughted ships and necessary port installations would be required, as well as a railway from the port to the growing areas, and this is mentioned in the summary and conclusions of their report.

The estimated tonnages of the groundnut scheme which were to be handed through the new port and which were exclusive of existing imports and exports covering present development of the area were given as follows:

Groundnuts	500,000	tons	max. p.a.
Imports (exclusive of oil)	300,000	,,	,, ,,
Bulk oil	100,000	,,	,, ,,

Three sites, namely, Lindi, Mto Mtwara, and Kilwa Kisiwani, were inspected, and the Mission made the following report on each:

Lindi

The present town and port of Lindi is situated on the north bank of the Lindi River at a point where it enters into the sea at Lindi Bay. The port, which consists only of a small jetty, at present in a bad state of repair and equipped with a small hand crane, is

Proposed Port for Tanganyika—continued

normally used by small coasters and dhows for the shipment of sisal and other local products. Two lighters only can lie alongside at one time and these are aground at low water. A total maximum discharging rate of 100 tons per day only can be obtained. The present annual tonnage handled through this port is as follows:

Imports (1946)	...	...	4,714 tons
Exports (1946)	...	...	15,954 tons

Only part of this tonnage is handled at the port jetty, the remainder being shipped from a number of small private piers attached to sisal estates in the Lindi River and vicinity.

There is at present in existence a bar across the harbour entrance, giving a depth of only 17-ft. at Low Water Ordinary Spring Tides, and we have carefully examined how this would effect deep-draughted ships which might have to use the port should it be developed. From the observations we have made and from the information which we have obtained, it would appear that vessels drawing over 25-ft. could not use the port, and vessels drawing over 21-ft. would be unduly restricted and subjected to considerable delays at certain times. It would therefore seem that any plan for the development of this place must take into account the dredging of a channel at this entrance and, in our opinion, maintenance dredging to maintain this channel would have to be accepted.

Within the harbour a site could be developed on the south bank by building a deep-water quay and reclaming behind to obtain an area for the necessary port installations. This area, however, would be restricted in depth owing to the sharp rise of the ground behind. The extent to which deep-water quays could be constructed and facilities provided for normal port working owing to the contour of the land would be limited, and then only to reclaimed areas.

At the present time anchorage for only four ships could be provided, and the maximum length of vessels which could be accommodated in such anchorage is, in our opinion, 450-ft. It would seem, therefore, that additional dredging beyond that required for the construction of the deep-water quay named above would be required to allow further anchorage, and a turning basin to provide for manœuvrability would be necessary.

We have considered the minimum requirements of the groundnut scheme to call for a deep-water quay 1,800-ft. in length to accommodate three ocean-going ships, one coaster berth and one oil berth, and we are bound to say that these could be provided in the site mentioned above. Any development, however, beyond this minimum requirement of the ground-nut scheme, would be difficult to provide without considerable additional dredging and reclamation. From our observations we consider it likely that any dredging undertaken within the harbour would require to be maintained owing to silt which comes down the river during the rainy season.

It is interesting to note that the present township of Lindi, lying, as it does, below high water level and having an unsatisfactory water supply, is planned by the Tanganyika Government, for considerations of health, for removal to a more satisfactory site on high ground. To some extent the same considerations of hygiene would apply to the site of the port which, at the present time, is a mangrove swamp and, because of its land-locked nature, is a sun-trap unrelieved by prevailing winds.

Further, we are not satisfied that full anchorage facilities to provide accommodation in the case of an unusually large number of vessels arriving in the port, which we know from experience is often the case, could be provided without even further development for anchorage facilities beyond that which we contemplate.

From the point of view of the rail connection between Lindi and the growing areas (Block A, *vide* plan), a suitable route clear of any major constructional difficulties is available, but only if the terminal is located on the south bank of the harbour, and it is this reason, to some extent, that dictates the selection of the only possible site for any port development. The distance of the railway line to Lindi from Block A would be 120 miles and would follow, in the main, an existing survey.

From the point of view of possible future use by the Services, Lindi is not altogether satisfactory, as will be clear from the particulars given above, and we doubt if any but the smaller of H.M. ships would be prepared to use the port even with the development which we indicate would be required for the groundnut scheme. The upper reaches of the harbour, however, would provide an admirable flying boat base.

Mto Mtwara

This natural harbour lies on the south-east of Mikindani Bay and is entered by a deep-water channel with a minimum navigable width of 900-ft. at low water. The entrance is protected from the south-east and has a minimum depth of water of 13 fathoms. There is no bar, and ships of any draught can enter and leave at any state of the tide. Within the entrance there exists a large and well-sheltered harbour affording anchorage to an unlimited number of vessels of any length or draught in complete safety, with good holding ground. The entrance to this harbour has an advantage enjoyed by, we believe, very few harbours on the east coast of Africa, in that it lies in a north to south direction, thus making for the easy recognition of navigational marks at all times of the day.

Within this harbour suitable sites for the construction of deep-water quays and port installations are available both on the north and south banks of the harbour, the preference being for a site on the south side of the harbour between Mtwara village and Pwazie Creek. Here ample room is available for the construction of facilities for the requirements of the groundnut scheme, as well as future developments. The land at this point is flat and will afford ample space for port installations and general port area development, as well as a township and rail terminal.

The district is a healthy one, and enquiries by us elicited that malaria among the natives is rare, if not unknown. Our own impressions, which were confirmed by those of the Provincial Commissioner and his officers, were to the effect that there is left little to be desired from this point of view.

The existing water supply, although limited to the small needs of the locality, is of good quality, but further investigation will require to be made to ascertain if sufficient volume to meet the needs of the future contemplated developments is available

Proposed Port for Tanganyika—continued

locally. It would appear, however, if such is not the case, that a supply could be obtained from a not impracticable distance.

The route of the proposed railway to Mto Mtwara, Block " A," as in the case of Lindi, Block " A," would serve an area already populated and under development.

There are obvious advantages at Mtwara from the point of view of any requirement by the Services in the future. The entrance to the harbour would lend itself particularly well to boom defence measures, while H.M. ships of the largest size could enter and leave the port at all states of the tide, as well as enjoying safe anchorage within the harbour out of sight from the sea. In addition the harbour could provide a suitable site for a flying boat base, while the adjacent land appears to lend itself very well to aerodrome construction.

Kilwa Kisiwani

In view of our instructions that we should pay first attention to the possibilities of developing Lindi because of its potential advantages, and the views we felt bound to come to in regard to Mto Mtwara having similar advantages, we have not thought it necessary to make the same detailed examination of the possibilities of Kilwa Kisiwani as would otherwise have been the case. We have visited this place, and examined its possibilities in general terms and, as a result, are able to report that it is a fine natural harbour of considerable extent, and development of a deep-water port would appear to be possible at certain sites within its area, the most favourable appearing to be Port Beaver.

The main disadvantages of this harbour lie in its distance from the main growing area, which would necessitate a length of railway to the growing areas considerably greater than that from either Lindi or Mto Mtwara, and the fact that such railway would not help any existing or future development beyond the groundnut scheme. The route from Kilwa Kisiwani to the main growing area in Block "A" would pass through a virtually unpopulated area from which, under present Government plans, the small existing population is being removed.

Estimated Costs

Certain estimates of costs are given in the Wakefield Report. In particular, a sum of £1,250,000 is named as covering for the new railway, deep-water berths, bulk storage and port installations required in the Southern Province. Since these estimates were made the scheme has developed to an extent which indicates that this figure is considerably below what the requirements are likely to cost, and we feel it would be wrong to allow this statement to remain without drawing attention to what we think the commitment for these constructions is likely to entail.

In regard to the cost of the railway, we have conferred with the General Manager of the Tanganyika Railways, who has given us the following estimated figures:

Cost of railway from Lindi Block " A," including rolling stock	£1,500,000
Cost of railway from Mto Mtwara to Block " A," including rolling stock	£1,850,000
Cost of port facilities as follows:	
Three deep-water berths, 1 coaster berth, 1 oil berth, bulk storage, loading plant and normal port installations	£2,000,000

This figure will apply equally to Lindi or Mtwara.

It will be seen that the total approximate estimated cost for port construction and railway is as follows:

1 Lindi	£3,500,000
2 Mto Mtwara	£3,850,000

Any sum required for the acquisition of land has not been included in these figures and the estimate of £3,500,000 for port construction and railway at Lindi does not take into account an annual sum required for maintenance dredging both at the bar and within the harbour.

Conclusions

Having investigated the whole of this matter with every possible care, and both inspected the available sites and conferred with local authorities, we have come to the following conclusions:

(a) In regard to Lindi, the natural restrictions of Lindi harbour call for the dredging of the existing bar and for maintenance dredging both of the entrance channel and of the harbour within the latter, to permit of increased anchorage facilities and turning basin. These facilities are, in our opinion, essential if harbour construction of a major nature such as is required is undertaken at this place. The annual cost of this maintenance dredging would have to be taken into consideration as an additional recurring charge and does not appear in our estimates given above.

(b) While it must be clearly stated that the required facilities could be provided within Lindi Harbour, any extension which might be required in the future as a result of the natural development of the Southern Province would be difficult and costly to provide. The only site which is available at Lindi is not one which we could recommend confidently, both from its lack of availability of space ashore for the natural development of commercial undertakings usually associated with ports and because of its distance from any suitable site for a new township.

(c) We have been very impressed with the natural facilities which exist at Mto Mtwara, offering, as they do, a complete lack of any restriction to ships of any size or draught both entering and leaving the harbour at all states of the tide. The anchorage within the harbour leaves nothing to be desired, and the land within is suitable for the purpose which is proposed.

(d) The relative costs of railway construction from the growing areas to either of these ports shows a preference for the line to Lindi inasmuch it is estimated to cost some £350,000 less than the line to Mtwara, and further, it is likely to take six months less to provide the Lindi line than the Mtwara line. We have weighed this matter very carefully in our minds, and, with a full appreciation of the urgency with which the scheme is required to be in full production, we believe that the estimated times are more likely to be realised in the case of Mtwara, and the advantages both from a short term and long term point of view, which are clearly to be obtained from the development of Mtwara, go a long way to justify an increase capital cost of the railway of some £350,000.

(e) It has been impressed upon us that the Southern Province of Tanganyika Territory is like to prove rich in other resources besides the groundnut scheme, and, with transport facilities such as are at present envisaged, development in other directions is probable. An extension of the railway beyond the present projected groundnut growing areas to Songea and eventually to Manda on Lake Nyasa would tap areas of production for many commodities as well as mineral resources, some of which are already under development and finding their way to the seaboard through Portuguese East Africa to the Port of Beira. While there is no definite evidence which we can report, these indications from reliable sources of considerable potentialities can, we think, properly be taken into account in our plans at this present stage. For this reason we consider it would be prudent to favour a site for the port which is capable of further extensions in the future, should these developments be realised.

We believe the interests and the aims of the groundnut scheme, and the future development of similar projects in this part of the world, which appear not improbable, would best be served by the construction of a new port at the south bank of the Mto Mtwara Harbour, capable of handling both the inward traffic for the present scheme and the export crop which it is estimated will result from it. We therefore recommend with every confidence that this site should be decided on, and the work of harbour construction, port installations and the railway should be pressed ahead without delay. We are pleased to record, in making this recommendation, that it has the support of the Tanganyika Government.

[With regard to the estimated costs of the project, as quoted in the Report, the figures given have been published in the East-African press and also in this country. We understand however, that they must be regarded as purely tentative, since the final plan for the port development must await the result of further detailed surveys and planning by the Consulting Engineers. Furthermore, the decision as to the minimum facilities necessary to handle the traffic of the groundnut scheme will be reviewed in the light of the practical experience at present being obtained at Dar Es-Salaam where the first shipments of equipment for the initial operation are now being handled—Editor.]

Port Facilities and their Operation at Southampton

Being extracts from a Paper by Mr. R. P. BIDDLE, C.B.E., Docks and Marine Manager, Southern Railway Company, Southampton, recently read to the Railway Students' Association*

Southampton Harbour Board

I think it is pertinent to point out that unlike the position at ports such as London, there is at Southampton a separate Port Authority called the Southampton Harbour Board, in whom is vested the control of the Port and Harbour as distinct from the docks, which are owned and managed entirely by the Southern Railway. Broadly speaking, the Southampton Harbour Board is responsible for the maintenance of the required depth of water in the navigable channels from the sea, for lighting and buoying and other navigational aids in the harbour waters, etc. There is, of course, an agreed line of demarcation between the Railway Company and the Harbour Board as to the limit of the respective water areas. Close co-operation is maintained between the two bodies, and the Railway Company is represented on the Board.

Before I deal more fully with the question of facilities and their relationship to Docks Operation, I think I ought to make a brief reference to the physical situation of the Port of Southampton and the history of the growth and development of the docks.

Physical Situation

The Port of Southampton is situated at the head of an estuary, six miles in length, called Southampton Water, and has the advantage of being practically at the centre of the South Coast of England. It moreover has further advantages of an entry either from the east or west, the shelter of the Isle of Wight, and the depth of water necessary. The prolonged periods of high water are due to a double tide, which feature is unique to Southampton. These double tides are a peculiar phenomenon, the second high water occurring two hours after the first, and between the first and second high water there is practically slack water. It is authoritatively stated that this is caused by that portion of the incoming tidal wave from the Atlantic, which rounding the North Coast follows down the East Coast of Great Britain and passes westward through the Straits of Dover, meeting between Southampton and St. Malo, France, that portion of the next incoming tidal wave from the Atlantic which has entered the English Channel. Thus the first high tide at Southampton is followed by its counterpart which forms the second high tide approximately 14 hours later. Low tides occur approximately 5½ hours after the first high tide. This feature is of the greatest value and is much appreciated by the shipping using the Port. The main waterway from the English Channel to the docks is 600-ft. wide, opening to 1,000-ft. at its mouth, with a depth of 35-ft. L.W.O.S.T.

The tidal range between high and low water is moderate, being 13-ft. on spring tides; this comparatively small range of tidal rise and fall has made closed docks unnecessary, and the heavy delay and expenses which such docks usually entail for ships are entirely avoided.

The approximate tidal ranges at other well-known ports are:—

Avonmouth	40-ft.
Liverpool	37-ft.
London and Hull	21-ft.

Historical Background

Southampton, as a seaport, has figured in historical records from early Christian times, but the trade and prosperity of the port may be said to have commenced with the Norman Conquest. The inception of the docks era actually dates from 1836 when the Southampton Dock Company was formed at a gathering at the " George and Vulture " Tavern in Lombard Street of a number of business men from London, Liverpool, Manchester and Southampton who met there on August 16th, 1836, imbued with the desire to develop the potentialities of the Port of Southampton. The optimism with which the venture was launched is evidenced by the report made at the time which says:

> " The Directors recorded their opinion that the new Docks would establish a position calculated to attract the commerce of the world."

Two years later the foundation stone was laid and the construction of what became known as the Outer Dock was started. In 1892, as I have already indicated, an important change of ownership occurred when the Southampton Dock Company, having encountered financial difficulties, sold their undertaking to the L. & S.W. Railway, now merged into the Southern Railway, the present owners and managers of Southampton Docks.

Development Under Railway Control.

Under railway control the expansion of the docks has been impressive. With the extension of the quays along the Rivers Itchen and Test between 1895 and 1902; the opening of the Ocean Dock in 1911; and the great Docks Extension Scheme of 1927-1934, the accommodation was increased by nearly 16,000-ft. In addition, three new dry docks, including one of the worlds largest—the King George V Graving Dock—were built.

It is interesting to note the increase in population that has occurred parallel with the development of the docks:—

1836 (inauguration of Southampton Dock Company ...	23,500
1892 (Docks taken over by Railway Company) ...	65,600
Present Day	180,000

Port Facilities

The facilities provided by the Southern Railway Company include quays, dredging within 600-ft. from the quays, cranes and other appliances; railways and roads, sheds, warehouses, dry docks, shore labour for shipping and receiving from ships and cartage services. Ship repairing (except on the Southern Railway's own vessels), pilotage, towage, stevedoring, mooring and bunkering are operated by independent organisations.

Problems of Large Liners

In each succeeding extension of the docks the depth of water at the quays has had to be increased. This can be explained by the parallel increase in ships' draft, but it is a problem of particular concern for Southampton since for so many years the port has accommodated the largest ships in the world. If such ships have brought Southampton fame and glory they have also presented their problems. A depth of 40-ft. at low spring tide has to be maintained, but few ships require such a depth. Furthermore, these immense liners require a corresponding length of quay for berthing, and as they do not carry much cargo the use of the quay space itself for discharging operations is necessarily limited. Similarly with dry docks. The King George V Graving Dock was primarily built for the *Queen Mary*, but the number of liners requiring a dock of such magnitude is extremely few, of course, these special facilities must be provided.

Quay Lay-Out, Etc.

The quay is the governing factor of the earning power of a port and the more ships that can be accommodated alongside a quay over a given period and the more goods and passengers that can be handled over it in a given space of time, the greater the earning power of that quay and also the lower it is possible to make the charges for the use of it, since standing and supervision costs are spread over a greater volume of trade.

It is of the utmost importance, therefore, that the quay and equipment must be so designed to avoid congestion and to enable the ship to be discharged as expeditiously as possible. The design of the quay depends on the type of port and shipping, the nature of the traffic dealt with and its method of disposal, e.g., traffic shipped overside or loaded direct to rail will require a lay-out different from that suitable for traffic direct ex ship to warehouse. At Southampton, by reason of the class of ship we regularly accommodate and the fact that most of our cargo traffic goes either direct from ship to rail truck on the quay or into the transit sheds

*The Paper, entitled " Docks Operation," covered a fairly wide field, part of which has already been, or is being, dealt with in the series of articles by Messrs. Bown and Dove now being published in this Journal. The extracts are confined to those portions of the Paper in which the practice at Southampton is described.

Port Facilities and their Operation at Southampton—continued

adjoining, we find it necessary to provide a particularly wide quay. Experience has taught us that the quay design adopted at our latest Docks Extension Estate, giving a width of 50-ft. and provision for a crane track and two railway tracks, is the best suited to our requirements.

Mechanical Equipment

All the quays are well equipped with electric cranes of modern pattern, and although in the past it was found those of 5-ton or 2-ton capacity were the most serviceable for general purposes, experience in recent years in dealing with heavier fruit loads inwards and machinery, etc., for export has shown that those of 3-ton or 6-ton capacity are preferable. More cranes of these capacities are therefore being introduced. The most practicable hoisting speeds for the 5-ton and 6-ton and for the 2-ton and 3-ton cranes have been fixed at 100-ft. per minute and 200-ft. per minute respectively. Most of the quays are equipped with 18-ft. gauge rails for the crane wheels, and it is intended to stardardise this gauge throughout the docks, as it is found that this dimension not only suits the quays but also enables a crane of greater stability, with the necessary height and outreach, to be erected. The standardisation also permits transfer of cranes from one quay to another as required.

Besides the quayside cranes and larger cranes at the dry docks, there are also 5-ton mobile cranes, which are not confined to tracks and which are used for loading heavy packages into rail wagons; and also, overhead electric travelling cranes for use in the 2-storey sheds at the Itchen quays. There are also two floating cranes of 150-tons and 60-tons respectively, which are called on to do a variety of different jobs. They have lifted engines and coaches, yachts, tanks, L.C.T.'s, and one of them was once required to raise a 100-ton barge that had been sunk in the river.

In addition to cranes, many mechanical appliances are employed in docks operations. Discharge of grain to Messrs. Rank Mills on the Docks Extension Industrial Estate is carried out by pneumatic discharging plant having a capacity of 120-tons per hour, the grain being conveyed automatically to the Silo by conveyor belts housed in overhead gantries.

Specialised equipment is also available for the discharge of bananas. A series of collapsible canvas pockets travels continuously from the ship's hold to quayside. Bunches of the fruit in the hold are placed in the pockets and as they reach the quayside are transferred to an endless conveyor belt which passes to special steam-heated banana vans for despatch by rail.

The electric truck by its great flexibility on quay or in shed and by its reduction in handling time and costs has proved invaluable. The type generally used at Southampton is the elevating platform truck of 2-tons capacity. It has a steel platform measuring 3-ft. by 6-ft. 6-in., and wooden trays or stillages are used in conjunction with the truck. One tray can be left on the quayside for loading, one in the shed for unloading, while a third, loaded or empty, is carried on the truck between the quay and shed. By a sequence of loading, carrying into the shed, and unloading (or vice versa) the costly unit (i.e., as regards interest and depreciation charges)—the electric truck itself—is thus kept constantly in motion. Use is also made of electric tractors for handling booms, gangways and railway wagons.

Shed Accommodation

I now come to the question of sheds and here I would like to point out two noteworthy features of our docks operations which have a pronounced influence on the design and function of the shed. First, unlike the practice at some other large ports, a ship once berthed at Southampton normally remains at that berth throughout the operation of disembarking passengers, discharging cargo, and in most cases, the embarkation of passengers and shipping of cargo. Second, Southampton is not a great storage port in the sense that London, and to a lesser extent Liverpool, are. Although, of course, storage accommodation is provided, also refrigerated premises for certain traffics, the port is primarily a Transit Port. A considerable number of the ships using Southampton are mail, cargo and passenger liners on regular schedules. The commodities they carry are often high-class and perishable and, generally speaking, require to be despatched speedily to their destination. A large proportion of the traffic dealt with has to be forwarded to markets as quickly as possible, either direct ex-ship to trucks on the quayside or after sorting in the sheds. A comparatively short interval, therefore, occurs between the arrival of a cargo and its dispatch inland. It is such considerations that influenced the construction of the single floor transit shed, although on the Itchen quays, for the special needs of the South African wool and hides traffic which has to be stored for varying periods, three sheds of the two-storey pattern are employed.

As I have stated, many of the ships using Southampton land both passengers and cargo and the sheds, therefore, must be designed to meet the requirements of both. Although they did not come out of the war unscathed, I think it can be justly claimed that the sheds at the new docks are among the finest of their kind in existence. An idea of their spaciousness can be gauged from the fact that they are 150-ft. wide and from 1,274 to 1,666-ft. in length. They were originally planned in pairs, with a connecting buffet lounge and waiting room between them. The walls are built of reinforced concrete and brick, and the roofs are supported on two rows of braced steel columns resting on reinforced concrete piles. Of particular assistance in cargo and passenger working is the lack of obstructions and the natural lighting. The floor slopes from quayward side of the shed up to railway lines at the back of the shed, where it reaches full ordinary platform height. Full provision is made for loading and unloading road vehicles.

Rail Road Access

The importance of adequate rail and road access to all parts of the estate has not been overlooked. A well-planned system of dock railways and marshalling sidings, totalling nearly 70 miles, connects up all berths and sheds and warehouses to the main line of the Southern Railway and facilitates expeditious handling. The railway lines on the quay are especially useful for traffic direct ex-ship to rail or for traffic which can be shipped direct ex-truck, but they are also valuable for internal working, for transhipment traffic, etc. Ocean passenger expresses are operated over the dock railways direct to and from the transit sheds adjoining liner berths. Freight trains arriving at the docks with cargo for export have first to be "broken up" and the loaded trucks shunted to the appropriate shed or berth for shipment. In the reverse direction, loaded wagons with import cargo have first to be collected from berth, shed or warehouse and then marshalled into trains ready for despatch inland. A special traffic department in the docks is responsible for the whole of the marshalling and shunting operations and for providing passenger, rolling stock and freight stock for all train services from the docks. The fact that the docks are managed by a railway company does, of course, ensure smooth, efficient, and expeditious working in despatching and receiving traffic.

All quays and sheds are available for road vehicles, and the necessity for roads with first-class surfaces has been appreciated. At the Docks Extension Estate behind the transit sheds a road of reinforced concrete has been constructed 1½ miles long with access to all quays and premises and to the main highways of the country.

Foreshore and Coast Erosion

An Order under the Ministers of the Crown (Transfer of Functions) Act 1946, has been made, transferring as from the 16th April, 1947, all functions exercisable by the Minister of Transport in relation to the protection of the coast and tidal lands in England and Wales and in Scotland against erosion or other damage caused by action of the sea, to the Minister of Health for England and Wales, and to the Secretary of State for Scotland.

Further, the duties of the Minister of Transport in the management of Crown foreshore and river and sea bed are being undertaken by the Commissioners of Crown Lands, 1, Cambridge Gate, Regent's Park, N.W.1. The consent of the Minister in the interests of navigation should, however, continue to be sought to the construction of any work which will extend below high water mark of ordinary spring tides.